Construction Stormwater Pollution Prevention Plan (CSWPPP)

East Town Crossing

1001 Shaw Road, Puyallup, WA 97372 USA

10/2/2023

Project Address
1001 Shaw Road
Puyallup, WA 97372

Owner
East Town Crossing LLC
Contact: Greg Helle

Prepared By:
Will McInnis
McInnis Engineering
202 East 34th Street
Tacoma WA, 98404
(253) 414-1992

202 East 34th Street
Tacoma, WA 98404

Project Engineer's Certification:

"I hereby state that this Construction Stormwater Pollution Prevention for the East Town Crossing project has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that the City of Puyallup does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me."

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McInnis ENGINEERING

202 East 34th Street
Tacoma, WA 98404

Proposed Project Description

The project address is 1001 Shaw Road, Puyallup, WA 98372. Parcel Numbers 0420264021, 0420264053, 0420264053, 0420351066, 0420351030, 0420351029, 0420351026. The project will include a commercial area containing 2 commercial buildings, and 5 multifamily buildings totaling 120 units.
The proposed project limits and clearing area consist of approximately 460,000 sq. ft. This includes the area of the new parking areas and the drive aisles.

In existing conditions, the land is grassy with a network of existing dirt/gravel access roads. It also houses a stormwater pond serving the nearby Absher Construction office complex. The soil is classified as Briscot Loam and Puyallup Fine Sandy Loam from Web Soil Survey. Multiple soils reports and groundwater monitoring have been completed for the project by Krazan & Associates that document the lack of infiltration on the site. We have also provided a letter in this report from the new geotechnical engineer on the project, Migizi Group, identifying the lack of infiltration on the site.

There is an offsite stream that abuts E Pioneer Ave in the right-of-way and currently enters the existing storm pond at the east side of the project site via a broken berm. The project has established 50-foot minimum setbacks from the stream on Pioneer (Stream Z) and a 35-ft. setback from the stream entering the pond (Stream Y). The project is coordinating with the WA Department of Fish & Wildlife, US Army Corps of Engineers and the local tribes for the ponds repair and stream relocation for the eventual E Pioneer Ave Road widening, included in phase 2 of this project. The relocation and on-site work in the buffer will commence following the Federal and State approvals and is not a part of this submittal.

There are no identified offsite wetlands to the east of the project site as identified by Soundview Consultants in their Technical Memorandum dated April 13, 2023.

The project will be accessed from E Pioneer Ave during construction. No construction access will be allowed from Shaw Road.

For this project, we have submitted phase 1 plans (as a separate submittal to the City of Puyallup, permit no. PRCCP20230970) and this Clear, Fill and Grade plan and report. Our Clear, Fill and Grade submittal seeks to obtain approval to begin clearing and grading activities on the site, import and place the required soil, and install the R-Tanks. By the time that construction is complete, it is our goal to have phase 1 approval so that the project can continue without having to demobilize the contractor. It is also our goal to go from phase 1 to phase 2 of the project, which will include the buildings on the east side of the project, the Stream Z relocation, and the construction of the Pioneer frontage without having to demobilize from the site.

This submittal is for the Clear, Fill and Grade associated with phase 1 only. We have included, however, the WWHM sizing calculations for the R-Tanks in Appendix C of the report. We have also included the discussion of the infeasibility of all the elements of the list approach in Appendix D. These items will also

be included in the storm report submittal for Phase 1, but are included here in the hope of getting the full Clear, Fill and Grade for the site, including the installation of the R-Tanks.

The proposed project has an approximate clearing and grading area of 10 acres and the entire property is over 11 acres. Earthwork estimates consist of 441 cubic yards (CY) of cut and 32,936 CY of fill for a net of 32,495 CY of fill. These estimates do not include stripping. The topsoil may be stockpiled for reuse on the site and/or for amending the soils per soil amendment BMP requirements. See below for how each of the 13 elements of the Stormwater Pollution Prevention Plan (SWPPP) are addressed as follows.

Element # 1: Preserve Vegetation/Mark Clearing Limits

- Clearing limits as shown on the plan and as noted, shall be marked using high visibility plastic fencing. All vegetated area outside the marked clearing limits shall be preserved in existing conditions. Fencing will also be used to protect the existing storm facility and critical area buffers. See BMPs C102 and C103.

Element # 2: Established Construction Entrance

- As shown on the plans, a construction entrance is provided at the northeast corner of the site off Pioneer per City of Puyallup standards. Any sediment tracked on to public ROW is the responsibility of the contractor and must be cleaned. See BMPs C105, C106, and C107

Element # 3: Control Flow Rates

- Straw wattles shall be provided to prevent erosion and control flow rates leaving the site. The velocity of water leaving the site shall not exceed 3 ft/s if the discharge is to a stream or a ditch. Clearwater Services has designed a Baker Tank and filtration assembly to control the stormwater release rate and quality before its discharge to Stream Z. In addition, a dispersion system at the edge of the buffer setback will provide discharge to the natural drainage location. Permanent flow control systems must be constructed and functioning prior to constructing onsite hard surfaces. See BMP C253, C251

Element # 4: Install Sediment Control

- Construct sediment control BMPs as one of the first steps of grading. These BMPs shall be functional before other land disturbing activities take place. Silt fence will be placed along all the downgradient boundaries of the proposed project limits to prevent any sediment laden runoff from leaving the site, as shown on plans. The contractor needs to protect all catch basins and adjust silt fencing as necessary to keep sediment laden runoff onsite. A temporary sediment pond has been designed as a portion of the Baker Tank system and will be the first sediment-reducing feature in a series of storage and filtration facilities. The sizing of the overall Baker Tank system can be found in Appendix A. See BMPs C200, 201, C233, C241.

Element # 5: Stabilize Soils and Dust Control

- Per the standard erosion control notes provided on the plans, all exposed soils shall be hydroseeded and covered if left unworked for a period of 7 days between May 1st- September 30th and for a period of 2 days between October 1st and April 30th. Stabilize soils at the end of the shift before a Holiday or weekend if needed based on the weather forecast. Stabilize soil stockpiles from erosion, protect with sediment trapping measures, and where possible locate stockpiles away from drainage facilities (waterways, storm inlets, channels, etc.). See BMPs C120, C121, C123 and C140.

Element # 6: Protect Slopes

- The majority of the site has flat slopes of 0-3%. There are small, isolated areas of greater than 3% slopes. No slopes over 20% are being disturbed. All exposed soils not covered by the buildings, roadway, or sidewalks will be hydroseeded, and there will be no slopes greater than 2:1. Interceptor swales will be used to protect slopes and direct water to a temporary sediment pond. Divert offsite surface water (run-on) away from slopes and disturbed areas with interceptor swales and pipes.

Element # 7: Protect Drain Inlets

- Drain inlets are being protected from sediment and high energy flows through the use of catch basin inserts. Catch basin inserts will be installed in any existing catch basins within 500 feet from the project site including structures on Shaw Road E and Pioneer Way E. Inlet protection devices will be cleaned (or removed and replaced), when sediment has filled the device by one third (1/3) or as specified by the manufacturer. Inlets will be inspected weekly at a minimum and daily during storm events. See BMPs C207, 208, C220.

Element # 8: Stabilize Channels and Outlets.

- There is an existing channel along Pioneer Way E that will be protected as necessary. Provide stabilization, including armoring material (if approved) adequate to prevent erosion of outlets, adjacent stream banks, slopes, and downstream reaches, at the outlets of all conveyance systems. See BMP C209.

Element # 9: Control Pollutants.

- The only pollutants generated by this project are those that are commonly associated with the construction of a multi-family complex and commercial lots. The contractor is responsible to follow all City of Puyallup regulations and this CSWPPP. Contractor to follow all City of Puyallup pollution control standard, particularly when handling concrete and vehicle activity. See BMPs C151, C153 and C154. Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants. Handle and dispose of all pollutants, including waste materials and demolition debris that occur on-site in a manner that does not cause contamination of stormwater.
  Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks on containers within an impervious structure capable of

containing 110% of the volume contained in the largest tank with the containment structure. Double-walled tanks do not require additional secondary containment.
Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident. Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with a local sewer district approval. Apply fertilizers and pesticides in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Follow manufacturers' label requirements for application rates and procedures. Use BMPs to prevent contamination of stormwater runoff by pH-modifying sources. The sources for this contamination include, but are not limited to: bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waster streams generated from concrete griding and sawing, exposed aggregate processes, dewatering concrete vaults, concrete pumping and mixer washout waters. Adjust the pH of stormwater if necessary to prevent violation of the water quality standards. Assure that washout of concrete trucks is performed off-site or in designated concrete washout areas only. Do not wash out concrete trucks on to the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete onsite, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the state is prohibited. Obtain written approval from Ecology before using chemical treatment other than CO^2 or dry ice to adjust pH. See BMPs C151, C153, and C154.

Element # 10: Control De-watering

- The groundwater table is high on the site, so it was important to check if the plan will require dewatering. After consulting with the contractor, it was concluded that the project improvements are at a height above the observed groundwater so that dewatering will not be required. If dewatering is required, the contractor will be required to hire an experienced dewatering contractor and obtain any necessary permits. Handle highly turbid or contaminated dewatering water separately from stormwater. Discharge foundation, vault, and trench dewatering water, which has characteristics similar to stormwater, into a controlled conveyance system before discharge to a sediment trap or sediment pond. Clean dewatering water will not be routed through stormwater sediment ponds.

Element # 11: Maintain BMPs

- The contractor and property owner will be responsible for checking and maintaining all stormwater BMPs. Contractor to repair as needed. All temporary and permanent Erosion and Sediment Control (ESC) BMPs shall be maintained and repaired as needed to ensure continued performance of their intended function. Visual monitoring of all BMPs installed at the site will be conducted at least once every calendar week and within 24 hours of any stormwater or non-stormwater discharge from the site. If the site becomes inactive and is temporarily stabilized, the inspection frequency may be reduced to once every calendar month. See BMPs C150 and C160.

Element # 12: Manage the Project

- The owner and contractor will be tasked with managing the project and are responsible for ensuring all SWPPP measures are followed per the provided plans and this report. Erosion control is the responsibility of the onsite contractor. They will install additional erosion measures as necessary to keep sediment-laden stormwater from leaving the site.

Element # 13: Protect Low Impact Development BMPs

- The proposed TESC plan includes details for Filter Fabric Fence and Inlet protection. The TESC plan provided in Figure 2 outlines more details on each of these preventative measures taken to protect the area during construction. Contractor shall inspect LID proposed facility location pre and post construction to ensure no sediment laden water can enter the LID facilities area.

Pollution Prevention Team

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	TBD	
Resident Engineer	Jeff McInnis	253.414.1992
Emergency Ecology Contact	TBD	
Emergency Permittee/ Owner Contact	Greg Helle	253.606.6799
Non-Emergency Owner Contact	TBD	
Monitoring Personnel	TBD	
Ecology Regional Office	Southwest Regional Office - Lacey	360.407.6300

Monitoring and Sampling Requirements

Monitoring includes visual inspection, sampling for water quality parameters of concern, and documentation of the inspection and sampling findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements
- Site inspections
- Stormwater sampling data

File a blank form under Appendix H.

The site log book must be maintained on-site within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

The receiving waterbody, the Puyallup River, is impaired for: pH and sediment. All stormwater and dewatering discharges from the site are subject to an **effluent limit** of 8.5 su for pH and/or 25 NTU for turbidity.

Site Inspection

Site inspections will be conducted at least once every calendar week and within 24 hours following any discharge from the site. For sites that are temporarily stabilized and inactive, the required frequency is reduced to once per calendar month.

The discharge point(s) are indicated on the Site Map (see Figure 2) and in accordance with the applicable requirements of the CSWGP.

Stormwater Quality Sampling

Turbidity Sampling

Requirements include calibrated turbidity meter or transparency tube to sample site discharges for compliance with the CSWGP. Sampling will be conducted at all discharge points at least once per calendar week.

Turbidity Sampling Method

X	Turbidity Meter/Turbidimeter (required for disturbances 5 acres or greater in size)
	Transparency Tube (option for disturbances less than 1 acre and up to 5 acres in size)

The benchmark for turbidity value is 25 nephelometric turbidity units (NTU) and a transparency less than 33 centimeters.

If the discharge's turbidity is 26 to 249 NTU **or** the transparency is less than 33 cm but equal to or greater than 6 cm, the following steps will be conducted:

1. Review the SWPPP for compliance with Special Condition S9. Make appropriate revisions within 7 days of the date the discharge exceeded the benchmark.
2. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible. Address the problems within 10 days of the date the discharge exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when the Permittee requests an extension within the initial 10-day response period.
3. Document BMP implementation and maintenance in the site log book.

If the turbidity exceeds 250 NTU **or** the transparency is 6 cm or less at any time, the following steps will be conducted:

1. Telephone or submit an electronic report to the applicable Ecology Region's Environmental Report Tracking System (ERTS) within 24 hours. https://www.ecology.wa.gov/About-us/Get-involved/Report-an-environmental-issue
    - Southwest Region (Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Lewis, Mason, Pacific, Pierce, Skamania, Thurston, Wahkiakum,): (360) 407-6300

2. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible. Address the problems within 10 days of the date the discharge exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when the Permittee requests an extension within the initial 10-day response period
3. Document BMP implementation and maintenance in the site log book.
4. Continue to sample discharges daily until one of the following is true:
    - Turbidity is 25 NTU (or lower).
    - Transparency is 33 cm (or greater).
    - Compliance with the water quality limit for turbidity is achieved.
        - 1 - 5 NTU over background turbidity, if background is less than 50 NTU
        - 1% - 10% over background turbidity, if background is 50 NTU or greater
    - The discharge stops or is eliminated.

pH Sampling

pH monitoring is required for "Significant concrete work" (i.e. greater than 1000 cubic yards poured concrete or recycled concrete over the life of the project).The use of engineered soils (soil amendments including but not limited to Portland cement-treated base [CTB], cement kiln dust [CKD] or fly ash) also requires pH monitoring.

For significant concrete work, pH sampling will start the first day concrete is poured and continue until it is cured, typically three (3) weeks after the last pour.
For engineered soils and recycled concrete, pH sampling begins when engineered soils or recycled concrete are first exposed to precipitation and continues until the area is fully stabilized.

If the measured pH is 8.5 or greater, the following measures will be taken:

1. Prevent high pH water from entering storm sewer systems or surface water.
2. Adjust or neutralize the high pH water to the range of 6.5 to 8.5 su using appropriate technology such as carbon dioxide (CO_2) sparging (liquid or dry ice).
3. Written approval will be obtained from Ecology prior to the use of chemical treatment other than CO_2 sparging or dry ice.

pH Sampling Method

X	pH meter
	pH test kit
	Wide range pH indicator paper

Reporting and Record Keeping

Record Keeping

Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements
- Site inspections
- Sample logs

Records Retention

Records will be retained during the life of the project and for a minimum of three (3) years following the termination of permit coverage in accordance with Special Condition S5.C of the CSWGP.
Permit documentation to be retained on-site:

- CSWGP
- Permit Coverage Letter
- SWPPP
- Site Log Book

Permit documentation will be provided within 14 days of receipt of a written request from Ecology. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with Special Condition S5.G.2.b of the CSWGP.

Discharge Monitoring Reports

Cumulative soil disturbance is one (1) acre or larger; therefore, Discharge Monitoring Reports (DMRs) will be submitted to Ecology monthly. If there was no discharge during a given monitoring period the DMR will be submitted as required, reporting "No Discharge". The DMR due date is fifteen (15) days following the end of each calendar month.

DMRs will be reported online through Ecology's WQWebDMR System.

Notification of Noncompliance

If any of the terms and conditions of the permit is not met, and the resulting noncompliance may cause a threat to human health or the environment, the following actions will be taken:

1. Ecology will be notified within 24-hours of the failure to comply by calling the applicable Regional office ERTS phone number (Regional office numbers listed below).
2. Immediate action will be taken to prevent the discharge/pollution or otherwise stop or correct the noncompliance. If applicable, sampling and analysis of any noncompliance will be repeated immediately and the results submitted to Ecology within five (5) days of becoming aware of the violation.
3. A detailed written report describing the noncompliance will be submitted to Ecology within five (5) days, unless requested earlier by Ecology.

Specific information to be included in the noncompliance report is found in Special Condition S5.F.3 pf the CSWGP

Anytime turbidity sampling indicates turbidity is 250 NTUs or greater, or water transparency is 6 cm or less, the Ecology Regional office will be notified by phone within 24 hours of analysis as required by Special Condition S5.A of the CSWGP.

- Southwest Region at (360) 407-6300 for Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Lewis, Mason, Pacific, Pierce, Skamania, Thurston, or Wahkiakum

Include the following information:

1. Your name and / Phone number
2. Permit number
3. City / County of project
4. Sample results
5. Date / Time of call
6. Date / Time of sample
7. Project name

In accordance with Special Condition S4.D.5.b of the CSWGP, the Ecology Regional office will be notified if chemical treatment other than CO_2 sparging is planned for adjustment of high pH water.

202 East 34th Street
Tacoma, WA 98404

Figure 1: Vicinity Map

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East Town Crossing
Vicinity Map

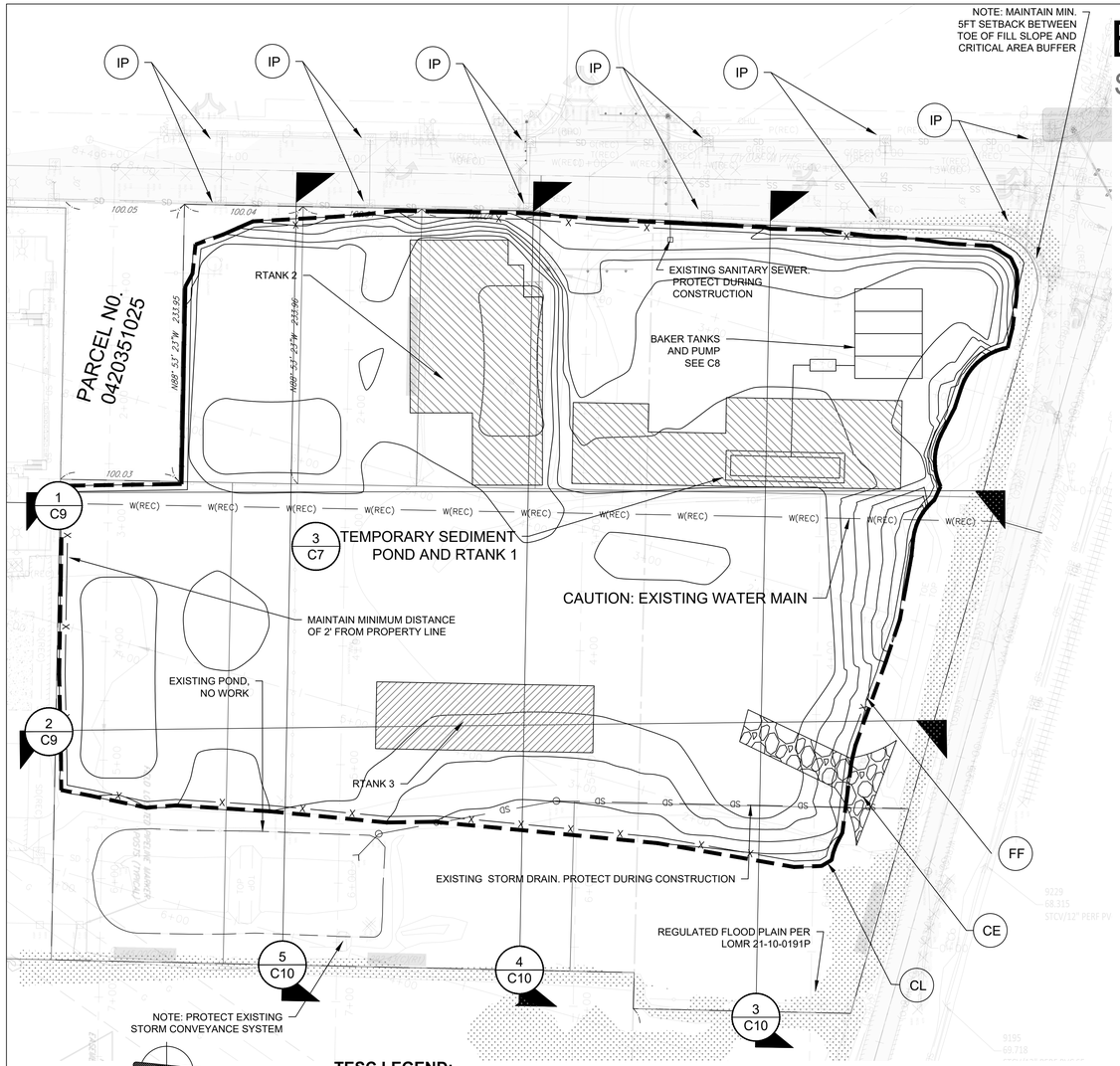
Figure #1

202 East 34th Street
Tacoma, WA 98404

Figure 2: Temporary Erosion/Sediment Control Plan

EAST TOWN CROSSING

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



TESC INSPECTION NOTES:

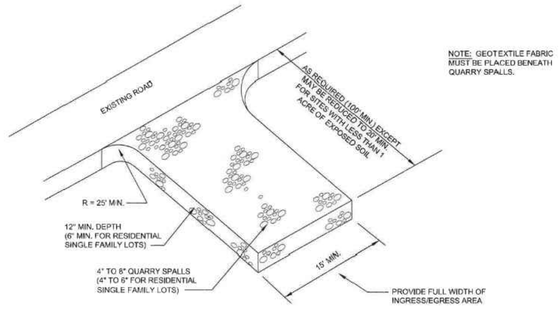
1. INSPECT ALL INLET PROTECTION ON CATCH BASINS. CLEAN OR REPLACE IF FULL OF SEDIMENT /DEBRIS AND REPAIR/REPLACE AS NEEDED IF DAMAGED TO MAINTAIN PROTECTION.
2. INSPECT ALL PERMANENT AND TEMPORARY STABILIZED SLOPES. REPAIR ANY DAMAGED SECTIONS AND RE-VEGETATE AS NEEDED TO ENSURE THE ESTABLISHMENT OF VEGETATION AND THAT NO EROSION OF THE SLOPES OCCUR.
3. INSPECT ALL FILTER FABRIC FENCING FOR SIGNS OF EROSION, DAMAGE OR FAILURES. REPAIR AND/OR REPLACE AS NEEDED. SEE FILTER FABRIC NOTES. SEDIMENT BUILD-UP ALONG FENCE SHALL BE REMOVED WHEN REACHES 1/3 THE FENCE HEIGHT. IF EROSION IS OCCURRING, CONTRACTOR SHALL INSTALL ADDITIONAL EROSION CONTROL MEASURES AS NEEDED TO PREVENT EROSION.
4. ANY FILL/CUT SLOPES SHALL BE INSPECTED FOR EROSION. IF SIGNS OF EROSION ARE PRESENT, INSTALL APPROPRIATE BMPS AS NEEDED TO STOP EROSION AND STABILIZE SLOPES.
5. TESC LEAD RESPONSIBLE FOR NOTIFYING ENGINEER IF ADDITIONAL MEASURES ARE WARRANTED.

PERMANENT STABILIZATION NOTES:

1. ALL EXPOSED SOILS AND SLOPES SHALL BE SEEDED OR OTHERWISE STABILIZED IMMEDIATELY AFTER CONSTRUCTION AND GRADING ACTIVITIES HAVE BEEN COMPLETED.
2. SILT FENCE, IF DEEMED APPROPRIATE, SHALL REMAIN FOR A MINIMUM OF 30 DAYS AFTER THE FINAL STABILIZATION OF THE SLOPES HAS OCCURRED.
3. ALL TEMPORARY EROSION CONTROL BMP'S SHALL BE REMOVED 30 DAYS AFTER FINAL STABILIZATION HAS OCCURRED AS DIRECTED BY CITY OR COUNTY INSPECTOR.
4. CONTRACTOR SHALL REFER TO THE CONSTRUCTION SWPP FOR APPLICABLE BMPS.

CONSTRUCTION ENTRANCE NOTES:

1. MATERIAL SHALL BE 4" TO 8" QUARRY SPALLS (4 TO 6 INCH FOR RESIDENTIAL SINGLE FAMILY LOTS) AND MAY BE TOP-DRESSED WITH 1 TO 3 INCH ROCK.
2. THE ROCK PAD SHALL BE AT LEAST 12" THICK AND 100' LONG (REDUCED TO 20 FEET FOR SITES LESS THAN 1 ACRE OF DISTURBED SOIL) WIDTH SHALL BE FULL WIDTH OF INGRESS AND EGRESS AREA. SMALLER PADS MAY BE APPROVED FOR SINGLE-FAMILY RESIDENTIAL AND COMMERCIAL SITES
3. ADDITIONAL ROCK SHALL BE ADDED PERIODICALLY TO MAINTAIN FUNCTION OF THE PAD.
4. IF THE PAD DOES NOT ADEQUATELY REMOVE MUD FROM THE VEHICLE WHEELS, THE WHEELS SHALL BE HOSED OFF BEFORE THE VEHICLE ENTERS A PAVED STREET.THE WASHING SHALL BE DONE ON AN AREA COVERED WITH CRUSHED ROCK AND WASH WATER SHALL DRAIN TO A SEDIMENT RETENTION FACILITY OR THROUGH A SILT FENCE.



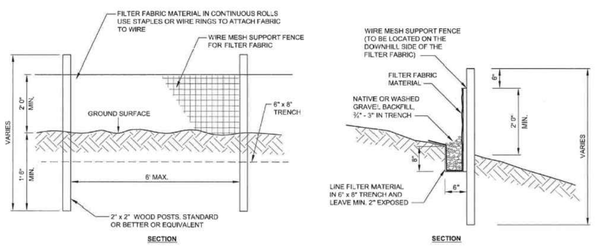
1 CONSTRUCTION ENTRANCE
SCALE:NTS

FILTER FABRIC FENCE NOTES:

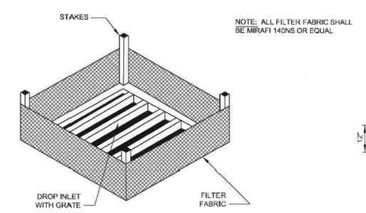
1. SUPPORT POST, WITH A MINIMUM 6-INCH OVERLAP. AND SECURELY FASTENED AT BOTH ENDS TO POSTS.
2. POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND (MINIMUM OF 30 INCHES).
3. A TRENCH SHALL BE EXCAVATED APPROXIMATELY 8 INCHES WIDE AND 12 INCHES DEEP ALONG THE LINE OF POSTS
4. AND UPSLOPE FROM THE BARRIER. THIS TRENCH SHALL BE BACKFILLED WITH WASHED GRAVEL.
5. WHEN STANDARD STRENGTH FILTER FABRIC IS USED, A WIRE MESH SUPPORT FENCE SHALL BE FASTENED SECURELY TO THE UPSLOPE SIDE OF THE POSTS USING HEAVY-DUTY WIRE STAPLES AT LEAST 1 INCH LONG, TIE WIRES OR HOG RINGS. THE WIRE SHALL EXTEND INTO THE TRENCH A MINIMUM OF 4 INCHES AND SHALL NOT EXTEND MORE THAN 24 INCHES ABOVE THE ORIGINAL GROUND SURFACE.
6. THE STANDARD STRENGTH FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE FENCE, AND 20 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 24 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO EXISTING TREES.
7. WHEN EXTRA-STRENGTH FILTER FABRIC AND CLOSER POST SPACING IS USED, THE WIRE MESH SUPPORT FENCE MAY BE ELIMINATED. IN SUCH A CASE, THE FILTER FABRIC IS STAPLED OR WIRED DIRECTLY TO THE POSTS WITH ALL OTHER PROVISIONS OF ABOVE NOTES APPLYING.
8. FILTER FABRIC FENCES SHALL NOT BE REMOVED BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
9. FILTER FABRIC FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
10. SILT FENCES WILL BE INSTALLED PARALLEL TO ANY SLOPE CONTOURS.
11. CONTRIBUTING LENGTH TO FENCE WILL NOT BE GREATER THAN 100 FEET.
12. DO NOT INSTALL BELOW AN OUTLET PIPE OR WEIR.
13. INSTALL DOWNSLOPE OF EXPOSED AREAS.
14. DO NOT DRIVE OVER OR FILL OVER SILT FENCES.

TESC LEGEND:

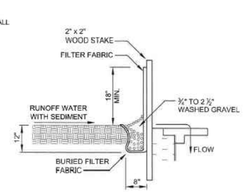
CL	CLEARING/ GRADING/ DISTURBED LIMITS
FF	FILTER FABRIC FENCE SEE DETAIL 2/C2
CE	CONSTRUCTION ENTRANCE 1/C2
IP	INLET PROTECTION 3/C2

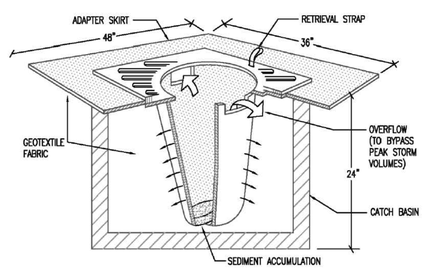


2 FILTER FABRIC FENCE
SCALE:NTS



3 INLET PROTECTION
SCALE:NTS





AMENDED SOILS NOTES:

- SOIL AMENDMENTS ARE REQUIRED FOR ALL DISTURBED AREAS IN ACCORDANCE WITH BMP L613: POST-CONSTRUCTION SOIL QUALITY AND DEPTH OF THE 2021 SURFACE WATER MANAGEMENT MANUAL
- AMENDED SOILS SHALL BE A MINIMUM OF 8" (NON-COMPACTED) WITH SUBSOILS SCARIFIED AT LEAST 4" WITH INCORPORATION OF THE UPPER MATERIAL TO AVOID STRATIFIED LAYERS, WHERE FEASIBLE.
- QUALITY OF COMPOST AND OTHER MATERIALS USED TO MEET THE ORGANIC CONTENT REQUIREMENTS ARE AS FOLLOWS:

a. THE ORGANIC CONTENT FOR "PRE-APPROVED" AMENDMENT RATES CAN BE MET ONLY USING COMPOST THAT MEETS THE DEFINITION OF "COMPOSTED MATERIALS" IN WAC 173-350-220. THE WAC IS AVAILABLE ONLINE AT: HTTP://WWW.ECY.WA.GOV/PROGRAMS/SWFA/FACILITIES/350.HTML THE COMPOST MUST ALSO HAVE AN ORGANIC MATTER CONTENT OF 35% TO 65%, AND A CARBON TO NITROGEN RATIO BELOW 25:1. THE CARBON TO NITROGEN RATIO MAY BE AS HIGH AS 35: 1 FOR PLANTINGS COMPOSED ENTIRELY OF PLANTS NATIVE TO THE PUGET SOUND LOWLANDS REGION.
b. CALCULATED AMENDMENT RATES MAY BE MET THROUGH USE OF COMPOSTED MATERIALS AS DEFINED ABOVE; OR OTHER ORGANIC MATERIALS AMENDED TO MEET THE CARBON TO NITROGEN RATIO REQUIREMENTS, AND MEETING THE CONTAMINANT STANDARDS OF GRADE A COMPOST.

- USE ONE OF THE FOLLOWING OPTIONS TO MEET THE POST CONSTRUCTION SOIL QUALITY AND DEPTH REQUIREMENTS. USE THE MOST RECENT VERSION OF "GUIDELINES FOR RESOURCES FOR IMPLEMENTING SOIL QUALITY AND DEPTH BMP T5.13" TO MEET THE REQUIREMENTS OF THIS BMP. THIS GUIDANCE CAN BE FOUND ONLINE AT:WWW.SOILSFORSALMON.ORG

a. LEAVE NATIVE VEGETATION AND SOIL UNDISTURBED, AND PROTECT FROM COMPACTION DURING CONSTRUCTION
b. AMEND EXISTING SITE TOPSOIL OR SUBSOIL EITHER AT DEFAULT "PRE-APPROVED" RATES, OR AT CUSTOM CALCULATED RA TES BASED ON SPECIFIC TESTS OF THE SOIL AND AMENDMENT
c. STOCKPILE EXISTING TOPSOIL DURING GRADING, AND REPLACE IT PRIOR TO PLANTING. STOCKPILED TOPSOIL MUST ALSO BE AMENDED IF NEEDED TO MEET THE ORGANIC MATTER OR DEPTH REQUIREMENTS, EITHER AT A DEFAULT "PRE-APPROVED" RATE OR AT A CUSTOM CALCULATED RATE.
d. IMPORT TOPSOIL MIX OF SUFFICIENT ORGANIC CONTENT AND DEPTH TO MEET THE REQUIREMENTS. MORE THAN ONE METHOD MAY BE USED ON DIFFERENT PORTIONS OF THE SAME SITE. SOIL THAT ALREADY MEETS THE DEPTH AND ORGANIC MATTER QUALITY STANDARDS, AND IS NOT COMPACTED, DOES NOT NEED TO BE AMENDED.

- AMENDED SOILS SHALL BE MAINTAINED AS FOLLOWS:

a. SOIL QUALITY AND DEPTH SHOULD BE ESTABLISHED TOWARD THE END OF CONSTRUCTION AND ONCE ESTABLISHED, SHOULD BE PROTECTED FROM COMPACTION, SUCH AS FROM LARGE MACHINERY USE, AND FROM EROSION.
b. SOIL SHOULD BE PLANTED AND MULCHED AFTER INSTALLATION.
c. PLANT DEBRIS OR ITS EQUIVALENT SHOULD BE LEFT ON THE SOIL SURFACE TO REPLENISH ORGANIC MA TIER.
d. IT SHOULD BE POSSIBLE TO REDUCE USE OF IRRIGATION, FERTILIZERS, HERBICIDES AND PESTICIDES. THESE ACTIVITIES SHOULD BE ADJUSTED WHERE POSSIBLE,RATHER THAN CONTINUING TO IMPLEMENT FORMERLY ESTABLISHED PRACTICES.

- SEE PROJECT CONSTRUCTION SWPPP FOR ADDITIONAL INFORMATION OR SECTION 2.2.1.4 OF CHAPTER 2 OF VOLUME 6 OF THE 2021 SURFACE WATER MANAGEMENT MANUAL

MULCHING NOTES:

1. MULCH MATERIALS USED SHALL BE STRAW OR HAY, AND SHALL BE APPLIED AT THE RATE OF 75-100 POUNDS PER 1000 SQ. FT. (APPX 2" THICK).
2. MULCH SHALL BE APPLIED IN ALL AREAS WITH EXPOSED SLOPES GREATER THAN 2: 1.
3. MULCHING SHALL BE USED IMMEDIATELY AFTER SEEDING OR IN AREAS WHICH CANNOT BE SEEDED BECAUSE OF THE SEASON.
4. ALL AREAS NEEDING MULCH SHALL BE COVERED BY NOVEMBER 1.

CONTRACTOR NOTES:

1. INLET PROTECTION SHALL BE INSTALLED IN ALL NEWLY CONSTRUCTED CATCH BASINS AND ALONG ALL IMPACTED FRONTAGE AND OFFSITE AREAS PER THE REQUIREMENTS OF THE COUNTY INSPECTOR PER DETAIL 5 ON THIS SHEET 5.
2. CONSTRUCTION FENCE CAN BE UTILIZED IN PLACE OF FILTER FABRIC FENCE ONLY IN AREAS WHERE THE GRADES DO NOT ALLOW THE POTENTIAL FOR ANY STORMWATER TO LEAVE THE SITE.
3. ALL DEMOLISHED MATERIALS SHALL BE REMOVED FROM THE SITE AND DISPOSED OF AT A CITY APPROVED LOCATION AND IN A MANNER CONSISTENT WITH CURRENT REGULATIONS AND REQUIREMENTS.
4. ALL AREAS THAT WILL BE UNWORKED FOR MORE THAN SEVEN (7) DAYS DURING THE DRY SEASON OR TWO (2) DAYS DURING THE WET SEASON, SHALL BE COVERED WITH STRAW, WOOD FIBER MULCH, COMPOST, PLASTIC SHEETING, OR OTHER EQUIVALENT PER CURRENT CITY OR COUNTY STANDARDS. SEE SEEDING NOTES AND MULCHING NOTES ON THIS SHEET.
5. CONTRACTOR SHALL DESIGNATE A WASHINGTON DEPT OF ECOLOGY CERTIFIED EROSION CONTROL LEAD PERSON, AND SHALL COMPLY WITH THE CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP) PREPARED FOR THE PROJECT.
6. AT ANY TIME DURING CONSTRUCTION IT IS DETERMINED BY THE CITY OR COUNTY THAT MUD AND DEBRIS ARE BEING TRACKED ONTO PUBLIC STREETS WITH INSUFFICIENT CLEANUP, ALL WORK SHALL CEASE ON THE PROJECT UNTIL THIS CONDITION IS CORRECTED. THE CONTRACTOR AND/OR THE OWNER SHALL IMMEDIATELY TAKE ALL STEPS NECESSARY TO PREVENT FUTURE TRACKING OF MUD AND DEBRIS INTO THE PUBLIC ROW, WHICH MAY INCLUDE THE INSTALLATION OF A WHEEL WASH FACILITY ON-SITE.
7. SEDIMENT LADEN RUNOFF SHALL NOT BE ALLOWED TO DISCHARGE BEYOND THE LIMITS OF THE IMPROVEMENTS. ADDITIONAL MEASURES SHALL BE INSTALLED AS NEEDED.
8. SAND BAGS SHALL BE SECURELY PLACED AROUND INSTALLED CATCH BASINS WITH INLET PROTECTION AS FIELD AND WEATHER CONDITIONS WARRANT SO TO PROTECT ALL DISPERSION AND INFILTRATION TRENCHES SEDIMENT LADEN RUNOFF.
9. TREES WITHIN WORKING LIMITS TO BE SAVED, SHALL BE MARKED AS SUCH ON SITE AND PROTECTION FENCE PLACED AROUND EACH TREE.

SEEDING NOTES:

1. THE FOLLOWING SEED MIXTURE SHALL BE AS BELOW AND SHALL BE APPLIED AT THE RATE RECOMMENDED BY THE SUPPLIER.

TABLE D.3.2.B TEMPORARY EROSION CONTROL SEED MIX

	% WEIGHT	% PURITY	% GERMINATION
CHEWINGS OR RED FESCUE FESTUCA *RUBRA VAR. COMMUTATA OR FESTUCA RUBRA*	40	98	90
ANNUAL OR PERENNIAL RYE *LOLIUM MULTIFLORUM OR LOLIUM PERENNE*	40	98	90
REDTOP OR COLONIAL BENTGRASS *AGROSTIS ALBA OR AGROSTIS TENUIS*	10	92	85
WHITE DUTCH CLOVER *TRIFOLIUM REPENS*	10	98	90

2. SEED BEDS PLANTED BETWEEN MAY 1 AND OCTOBER 31 WILL REQUIRE IRRIGATION AND OTHER MAINTENANCE AS NECESSARY TO FOSTER AND PROTECT THE ROOT STRUCTURE.
3. FOR SEED BEDS PLANTED BETWEEN OCTOBER 31 AND APRIL 30, ARMORING OF THE SEED BED WILL BE NECESSARY. (E.G., GEOTEXTILES, JUTE MAT, CLEAR PLASTIC COVERING),
4. BEFORE SEEDING, INSTALL NEEDED SURFACE RUNOFF CONTROL MEASURES SUCH AS GRADIENT TERRACES, INTERCEPTOR DIKES, SWALES, LEVEL SPREADERS AND SEDIMENT BASINS.
5. THE SEEDBED SHALL BE FIRM WITH A FAIRLY FINE SURFACE, FOLLOWING SURFACE ROUGHENING. PERFORM ALL OPERATIONS ACROSS OR AT RIGHT ANGLES TO THE SLOPE.
6. FERTILIZERS ARE TO BE USED ACCORDING TO SUPPLIER'S RECOMMENDATIONS. AMOUNTS USED SHOULD BE MINIMIZED, ESPECIALLY ADJACENT TO WATER BODIES AND WETLANDS.

C-2

APPROVED

BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

NOTE: THIS APPROVAL IS VOID AFTER 180 DAYS FROM APPROVAL DATE.
THE CITY WILL NOT BE RESPONSIBLE FOR ERRORS AND/OR OMISSIONS ON THESE PLANS.
FIELD CONDITIONS MAY DICTATE CHANGES TO THESE PLANS AS DETERMINED BY THE DEVELOPMENT ENGINEERING MANAGER.

McInnis ENGINEERING
mcinnisengineering.com
253.414.1992
202 East 34th Street
Tacoma, Washington 98404

EAST TOWN CROSSING
GRADE AND FILL PLANS

2902 E PIONEER
PUYALLUP, WA 98372

JEFFREY W. MCINNIS
STATE OF WASHINGTON
37399
REGISTERED
PROFESSIONAL ENGINEER
10/2/23

NUM	DATE	DESCRIPTION

DESIGNED J. MCINNIS | SCALE 1"=60'
DRAWN W. MCINNIS | CHECKED CHCK
DATE 10/2/23 | APPROVED APRD

TESC PLAN

SHEET 2 OF 28

C-2

202 East 34th Street
Tacoma, WA 98404

Appendix A: Baker Tank Assembly Sizing Calculations, and Details

Site Specific Stormwater Runoff Assumptions - East Town Crossing

Project:	East Town Crossing
Location:	Puyallup WA

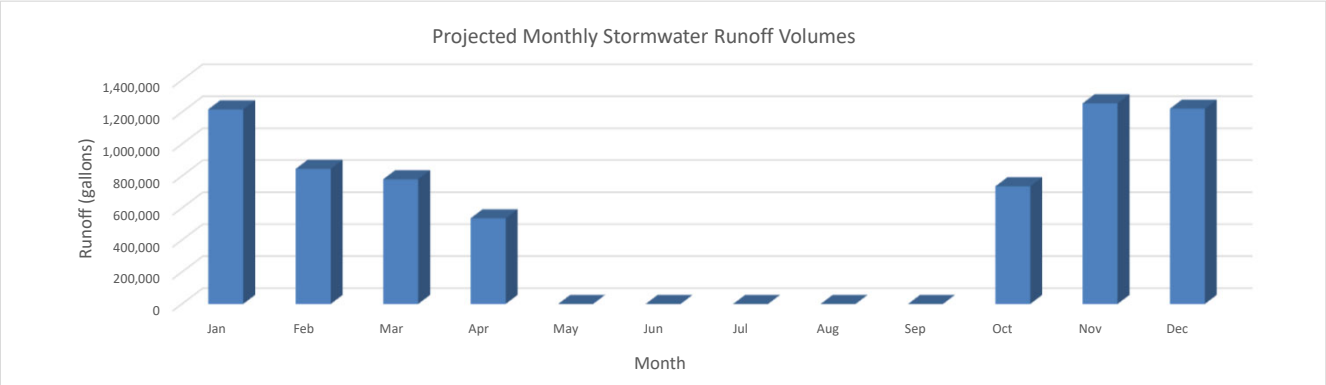
Acreage:	8.60
System Flow Rate:	600
Runoff Cooeficient:	0.90

Min Flow Rate (gpm):	**598**
Proposed Flow Rate (gpd):	**864,000**
Recommend Stor (gal):	**201,767**

Design Criteria	Runoff		Notes
1.5X 10yr 24hr Storm Event	**945,784**	Gallons	Required capacity per BMP C250
Treatment System Flow Capacity	**600**	GPM	Nominal Discharge Rate
Treatment System Flow Capacity	**864,000**	GPD	Nominal Discharge Rate
Storage Volume	**84,000**	Gallons	*Minimum* Recommended On-Site Storage Volume*(30k Gallon Pond, (3) 18k gallon Tanks*
Total System Capacity	**948,000**	Gallons	Treatment system flow rate (GPD) plus storage volume. Must be greater than the 1.5X 10yr 24hr Storm Event
Additional Capacity	**2,216**	Gallons	Total system capacity in excess of 1.5 times the 10YR, 24HR Storm Event

Storm Event	Precipitation (inches)	Runoff Volume (gal)	Duration (min)	Precip. Intensity (in/hr)	Peak Flow Total (gpm)
2-year 6-hour	0.96	**201,767**	360	0.16	**560**
2-year 24-hour	1.80	**378,313**	1440	0.08	**263**
10-year 24-hour	3.00	**630,522**	1440	0.13	**438**
1.5X 10yr 24hr	4.50	**945,784**	1440	0.19	**657**
100-year 6-hour	1.92	**403,534**	360	0.32	**1,121**
100-year 24-hour	3.80	**798,662**	1440	0.16	**555**

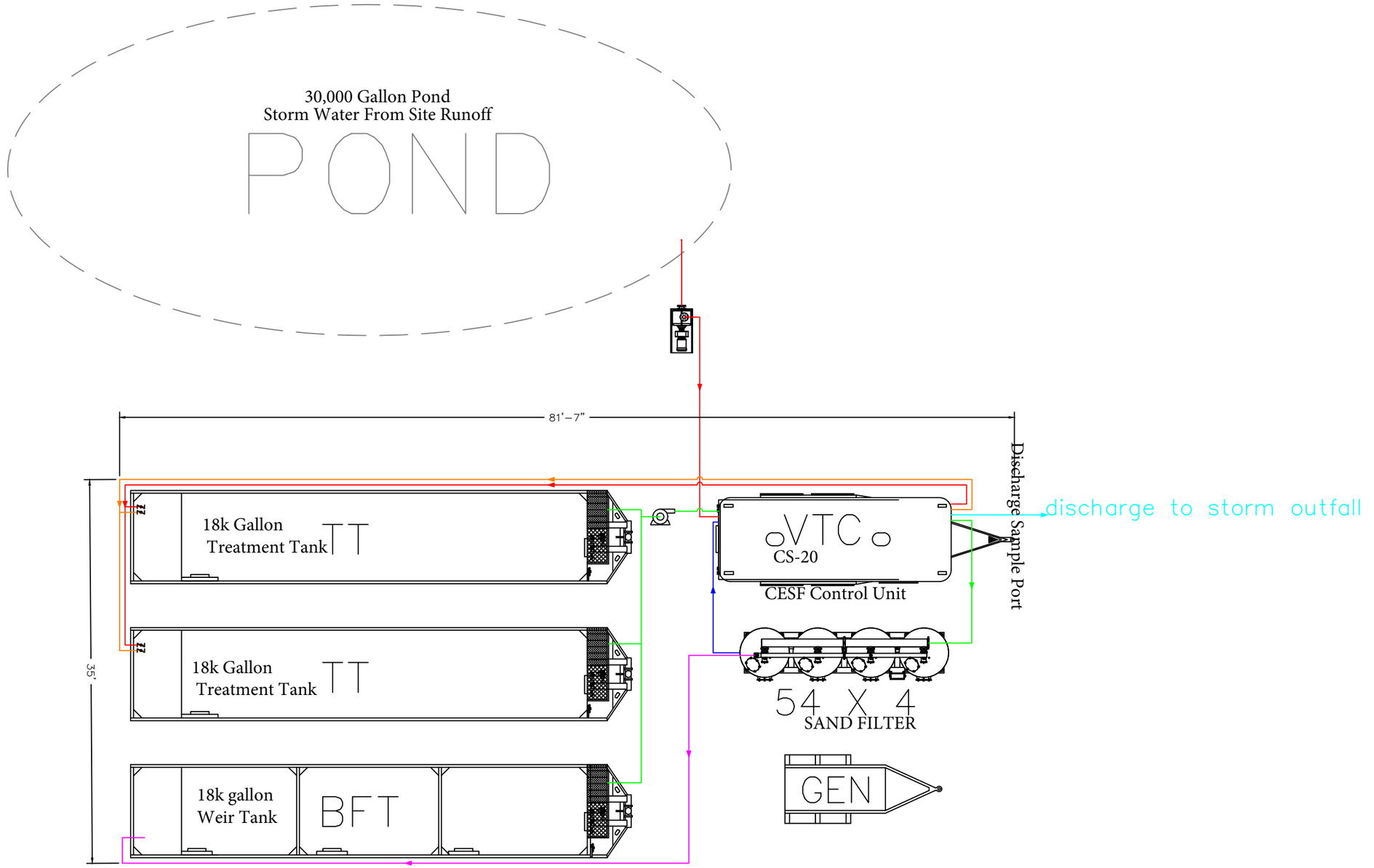
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Project Total
CESCL Inspections	8	6	6	5	0	0	0	0	0	6	8	8	47
Days Over 0.10"	13	10	11	7	5	4	2	3	5	8	13	13	75
Days Over 0.50"	4	2	2	1	1	1	0	1	1	2	4	4	19
Days Over 1.0"	1	0	0	0	0	0	0	0	0	0	1	1	3
Average Total Precipitation (in.)	5.79	4.02	3.71	2.55	1.7	1.45	0.77	1.1	1.72	3.5	5.97	5.81	31.35
Annual Runoff Volume (gallons)	1,216,908	844,900	779,746	535,944	357,296	304,753	161,834	231,192	361,500	735,610	1,254,740	1,221,112	8,005,534
Groundwater Contribution	0	0	0	0	0	0	0	0	0	0	0	0	0
Project Total Runoff Volume (gallons)	**1,216,908**	**844,900**	**779,746**	**535,944**	**0**	**0**	**0**	**0**	**0**	**735,610**	**1,254,740**	**1,221,112**	**6,588,960**



The assumptions above are based on an average rainfall over the past 20 years. While these assumptions typical balance out over long durations, variance of 20%-50% per month is typical.

LEGEND

- RAW WATER
- PRETREAT
- FILTER INFLUENT
- FILTER EFFLUENT
- BACKFLUSH
- DISCHARGE
- RECIRCULATION
- BUTTERFLY VALVE



East Town Crossing
PROJECT NO. WAC23ETCRS
600gpm
PROCESS FLOW DIAGRAM

DATE	REVISIONS

SHEET 1
1 OF 1

DATE: 7/13/2023 | DESIGNER: CWS | FILE NAME: WAC23ETCRS 600GPM LAYOUT.dwg

202 East 34th Street
Tacoma, WA 98404

Appendix B: Swale Sizing Calculations

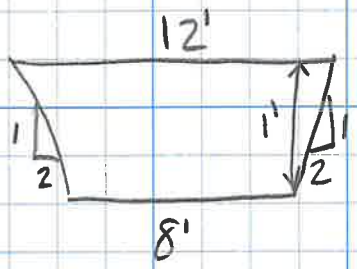
PROJECT NAME East Town Crossing PROJECT NO. 22-245

DATE 8/25/2023 BY K. Maas

McInnis ENGINEERING

Based on the 100 year peak flow found with the single event modeling software Storm Shed, the peak flow of 2.36 cfs will not cause erosive flows

Using the area of the fully filled channel



$A = 10 ft^2$

the max velocity will be 0.236 ft/s $\frac{Q}{A} = V$

To comply with ecology regulations flows must not exceed 3ft/sec so the swale has been designed to stay well below this rate.

Basin Compute Summary: Swale

Event	Peak Time (min)	Peak Time (hrs)	Peak Flow (cfs)	Volume (cf)	Volume (acft)
2 yr 24 hr	704.94	11.749	0.4599	24487.58	0.5622
5 yr 24 hr	676.16	11.2694	0.7599	36169.5	0.8303
10 yr 24 hr	676.17	11.2694	1.1132	49010.78	1.1251
25 yr 24 hr	661.78	11.0296	1.5028	62750.52	1.4406
50 yr 24 hr	661.78	11.0296	1.9239	77200.82	1.7723
100 yr 24 hr	661.78	11.0296	2.3658	92222.65	2.1171

Record Id: Swale

Design Method	SCS	**Rainfall type**	type1a.rac
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	10.36 ac	**DCIA**	0.00 ac
Pervious CN	75.00	**DC CN**	0.00
Pervious TC	202.9124 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Pasture or range - Contoured (fair), fair hydrologic condition	10.36 ac	75.00
Composite CN		75.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Grass	626.00 ft	0.36%	0.17	0.00 in	105.5302 min
Sheet	Grass	640.00 ft	0.46%	0.17	0.00 in	97.3821 min
Pervious TC						202.9124 min

Directly Connected TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	far reach	230.00 ft	0.5%	0.0	0.00 in	0.00 min
Directly Connected TC						5.00 min

202 East 34th Street
Tacoma, WA 98404

Appendix C: WWHM Calculations for R-Tank Sizing

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: East Town Crossing Model 1 9.13.23
Site Name:
Site Address:
City:

Report Date:	10/4/2023
Gage:	38 IN CENTRAL
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

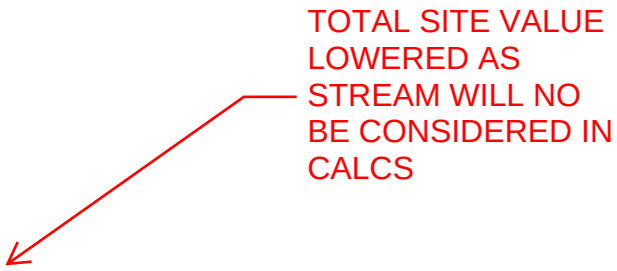
Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Landuse

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	10.11
Pervious Total	10.11
Impervious Land Use	acre
Impervious Total	0
Basin Total	10.11



Mitigated Land Use

Multifamily Phase 1

Bypass:	No
GroundWater:	No

NOTE: ALL WALKWAYS ARE PERVIOUS AND ARE SHOWN IN LATERAL BASINS

Pervious Land Use	acre
A B, Lawn, Mod	1.18
Pervious Total	1.18

Impervious Land Use	acre
ROADS MOD	1.86
ROOF TOPS FLAT	1.19
Impervious Total	3.05
Basin Total	4.23

Shaw Road Bypass

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Mod	0.18
Pervious Total	0.18
Impervious Land Use	acre
ROADS MOD	0.11
Impervious Total	0.11
Basin Total	0.29

NW Commercial

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Mod	0.12
Pervious Total	0.12
Impervious Land Use	acre
ROADS MOD	0.84
ROOF TOPS FLAT	0.24
Impervious Total	1.08
Basin Total	1.2

Multifamily Phase 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Mod	0.99
Pervious Total	0.99
Impervious Land Use	acre
ROADS MOD	0.9
ROOF TOPS FLAT	0.62
Impervious Total	1.52
Basin Total	2.51

Pioneer Road Bypass

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS MOD	0.28
Impervious Total	0.28
Basin Total	0.28

Landscape Bypass

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Steep	0.39
Pervious Total	0.39
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.39

BYPASS INCLUDES ALL CITY REQUESTED LANDSCAPING AREAS

Commercial Permeable Walkways

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Pasture, Mod	.18

LATERAL BASIN CONNECTS TO PERMEABLE PAVEMENT ELEMENT

Multifamily Permeable Walkways

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Mod	.96

Bypass Permeable Walkways

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Mod	.07

Routing Elements
Predeveloped Routing

Mitigated Routing

129ft x 129ft x 3ft =
49,923 cf

RTANK NW

Width: 129 ft.
Length: 129 ft.
Depth: 3 ft.
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 10 in.
Notch Type: Rectangular
Notch Width: 0.417 ft.
Notch Height: 1.000 ft.
Orifice 1 Diameter: 0.650 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

RTANK NW ACTUAL STORAGE

TOTAL SYSTEM STORAGE	49,977 CF
R-TANK STORAGE VOLUME	38,592 CF
STONE STORAGE VOLUME (40% VOID RATIO)	11,385 CF

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.382	0.000	0.000	0.000
0.0333	0.382	0.012	0.002	0.000
0.0667	0.382	0.025	0.003	0.000
0.1000	0.382	0.038	0.003	0.000
0.1333	0.382	0.050	0.004	0.000
0.1667	0.382	0.063	0.004	0.000
0.2000	0.382	0.076	0.005	0.000
0.2333	0.382	0.089	0.005	0.000
0.2667	0.382	0.101	0.005	0.000
0.3000	0.382	0.114	0.006	0.000
0.3333	0.382	0.127	0.006	0.000
0.3667	0.382	0.140	0.006	0.000
0.4000	0.382	0.152	0.007	0.000
0.4333	0.382	0.165	0.007	0.000
0.4667	0.382	0.178	0.007	0.000
0.5000	0.382	0.191	0.008	0.000
0.5333	0.382	0.203	0.008	0.000
0.5667	0.382	0.216	0.008	0.000
0.6000	0.382	0.229	0.008	0.000
0.6333	0.382	0.241	0.009	0.000
0.6667	0.382	0.254	0.009	0.000
0.7000	0.382	0.267	0.009	0.000
0.7333	0.382	0.280	0.009	0.000
0.7667	0.382	0.292	0.010	0.000
0.8000	0.382	0.305	0.010	0.000
0.8333	0.382	0.318	0.010	0.000
0.8667	0.382	0.331	0.010	0.000
0.9000	0.382	0.343	0.010	0.000
0.9333	0.382	0.356	0.011	0.000
0.9667	0.382	0.369	0.011	0.000
1.0000	0.382	0.382	0.011	0.000
1.0333	0.382	0.394	0.011	0.000
1.0667	0.382	0.407	0.011	0.000
1.1000	0.382	0.420	0.012	0.000
1.1333	0.382	0.433	0.012	0.000
1.1667	0.382	0.445	0.012	0.000
1.2000	0.382	0.458	0.012	0.000

1.2333	0.382	0.471	0.012	0.000
1.2667	0.382	0.483	0.012	0.000
1.3000	0.382	0.496	0.013	0.000
1.3333	0.382	0.509	0.013	0.000
1.3667	0.382	0.522	0.013	0.000
1.4000	0.382	0.534	0.013	0.000
1.4333	0.382	0.547	0.013	0.000
1.4667	0.382	0.560	0.013	0.000
1.5000	0.382	0.573	0.014	0.000
1.5333	0.382	0.585	0.014	0.000
1.5667	0.382	0.598	0.014	0.000
1.6000	0.382	0.611	0.014	0.000
1.6333	0.382	0.624	0.014	0.000
1.6667	0.382	0.636	0.014	0.000
1.7000	0.382	0.649	0.014	0.000
1.7333	0.382	0.662	0.015	0.000
1.7667	0.382	0.674	0.015	0.000
1.8000	0.382	0.687	0.015	0.000
1.8333	0.382	0.700	0.015	0.000
1.8667	0.382	0.713	0.015	0.000
1.9000	0.382	0.725	0.015	0.000
1.9333	0.382	0.738	0.015	0.000
1.9667	0.382	0.751	0.016	0.000
2.0000	0.382	0.764	0.016	0.000
2.0333	0.382	0.776	0.024	0.000
2.0667	0.382	0.789	0.040	0.000
2.1000	0.382	0.802	0.059	0.000
2.1333	0.382	0.815	0.082	0.000
2.1667	0.382	0.827	0.108	0.000
2.2000	0.382	0.840	0.136	0.000
2.2333	0.382	0.853	0.166	0.000
2.2667	0.382	0.865	0.198	0.000
2.3000	0.382	0.878	0.231	0.000
2.3333	0.382	0.891	0.266	0.000
2.3667	0.382	0.904	0.303	0.000
2.4000	0.382	0.916	0.340	0.000
2.4333	0.382	0.929	0.379	0.000
2.4667	0.382	0.942	0.419	0.000
2.5000	0.382	0.955	0.459	0.000
2.5333	0.382	0.967	0.501	0.000
2.5667	0.382	0.980	0.543	0.000
2.6000	0.382	0.993	0.586	0.000
2.6333	0.382	1.006	0.629	0.000
2.6667	0.382	1.018	0.673	0.000
2.7000	0.382	1.031	0.717	0.000
2.7333	0.382	1.044	0.762	0.000
2.7667	0.382	1.056	0.807	0.000
2.8000	0.382	1.069	0.853	0.000
2.8333	0.382	1.082	0.898	0.000
2.8667	0.382	1.095	0.944	0.000
2.9000	0.382	1.107	0.991	0.000
2.9333	0.382	1.120	1.037	0.000
2.9667	0.382	1.133	1.083	0.000
3.0000	0.382	1.146	1.129	0.000
3.0333	0.382	1.158	1.183	0.000
3.0667	0.000	0.000	1.281	0.000

RTANK COMBINED

167 ft x 168 ft x 5 ft = 140280 cf

Width:	168 ft.
Length:	167 ft.
Depth:	5 ft.
Discharge Structure	
Riser Height:	5 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	0.500 ft.
Notch Height:	1.800 ft.
Orifice 1 Diameter:	1.565 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

TOTAL SYSTEM STORAGE	62,623 CF
R-TANK STORAGE VOLUME	54,785 CF
STONE STORAGE VOLUME (40% VOID RATIO)	7,838 CF

TOTAL SYSTEM STORAGE	78,478 CF
R-TANK STORAGE VOLUME	66,414 CF
STONE STORAGE VOLUME (40% VOID RATIO)	12,064 CF

TOTAL OF 2 COMBINED SYSTEMS = 141,101 CF

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.644	0.000	0.000	0.000
0.0556	0.644	0.035	0.015	0.000
0.1111	0.644	0.071	0.022	0.000
0.1667	0.644	0.107	0.027	0.000
0.2222	0.644	0.143	0.031	0.000
0.2778	0.644	0.178	0.035	0.000
0.3333	0.644	0.214	0.038	0.000
0.3889	0.644	0.250	0.041	0.000
0.4444	0.644	0.286	0.044	0.000
0.5000	0.644	0.322	0.047	0.000
0.5556	0.644	0.357	0.049	0.000
0.6111	0.644	0.393	0.052	0.000
0.6667	0.644	0.429	0.054	0.000
0.7222	0.644	0.465	0.056	0.000
0.7778	0.644	0.500	0.058	0.000
0.8333	0.644	0.536	0.060	0.000
0.8889	0.644	0.572	0.062	0.000
0.9444	0.644	0.608	0.064	0.000
1.0000	0.644	0.644	0.066	0.000
1.0556	0.644	0.679	0.068	0.000
1.1111	0.644	0.715	0.070	0.000
1.1667	0.644	0.751	0.071	0.000
1.2222	0.644	0.787	0.073	0.000
1.2778	0.644	0.823	0.075	0.000
1.3333	0.644	0.858	0.076	0.000
1.3889	0.644	0.894	0.078	0.000
1.4444	0.644	0.930	0.079	0.000
1.5000	0.644	0.966	0.081	0.000
1.5556	0.644	1.001	0.082	0.000
1.6111	0.644	1.037	0.084	0.000
1.6667	0.644	1.073	0.085	0.000
1.7222	0.644	1.109	0.087	0.000
1.7778	0.644	1.145	0.088	0.000
1.8333	0.644	1.180	0.090	0.000
1.8889	0.644	1.216	0.091	0.000
1.9444	0.644	1.252	0.092	0.000
2.0000	0.644	1.288	0.094	0.000
2.0556	0.644	1.323	0.095	0.000
2.1111	0.644	1.359	0.096	0.000

2.1667	0.644	1.395	0.097	0.000
2.2222	0.644	1.431	0.099	0.000
2.2778	0.644	1.467	0.100	0.000
2.3333	0.644	1.502	0.101	0.000
2.3889	0.644	1.538	0.102	0.000
2.4444	0.644	1.574	0.103	0.000
2.5000	0.644	1.610	0.105	0.000
2.5556	0.644	1.646	0.106	0.000
2.6111	0.644	1.681	0.107	0.000
2.6667	0.644	1.717	0.108	0.000
2.7222	0.644	1.753	0.109	0.000
2.7778	0.644	1.789	0.110	0.000
2.8333	0.644	1.824	0.111	0.000
2.8889	0.644	1.860	0.113	0.000
2.9444	0.644	1.896	0.114	0.000
3.0000	0.644	1.932	0.115	0.000
3.0556	0.644	1.968	0.116	0.000
3.1111	0.644	2.003	0.117	0.000
3.1667	0.644	2.039	0.118	0.000
3.2222	0.644	2.075	0.124	0.000
3.2778	0.644	2.111	0.155	0.000
3.3333	0.644	2.146	0.200	0.000
3.3889	0.644	2.182	0.253	0.000
3.4444	0.644	2.218	0.314	0.000
3.5000	0.644	2.254	0.381	0.000
3.5556	0.644	2.290	0.453	0.000
3.6111	0.644	2.325	0.529	0.000
3.6667	0.644	2.361	0.608	0.000
3.7222	0.644	2.397	0.690	0.000
3.7778	0.644	2.433	0.775	0.000
3.8333	0.644	2.469	0.863	0.000
3.8889	0.644	2.504	0.951	0.000
3.9444	0.644	2.540	1.042	0.000
4.0000	0.644	2.576	1.133	0.000
4.0556	0.644	2.612	1.226	0.000
4.1111	0.644	2.647	1.318	0.000
4.1667	0.644	2.683	1.412	0.000
4.2222	0.644	2.719	1.513	0.000
4.2778	0.644	2.755	1.627	0.000
4.3333	0.644	2.791	1.745	0.000
4.3889	0.644	2.826	1.865	0.000
4.4444	0.644	2.862	1.989	0.000
4.5000	0.644	2.898	2.115	0.000
4.5556	0.644	2.934	2.244	0.000
4.6111	0.644	2.969	3.090	0.000
4.6667	0.644	3.005	3.267	0.000
4.7222	0.644	3.041	3.447	0.000
4.7778	0.644	3.077	3.630	0.000
4.8333	0.644	3.113	3.817	0.000
4.8889	0.644	3.148	4.006	0.000
4.9444	0.644	3.184	4.199	0.000
5.0000	0.644	3.220	4.395	0.000
5.0556	0.644	3.256	4.604	0.000
5.1111	0.000	0.000	4.984	0.000

NW Commercial Permeable Pavement

Pavement Area:1.2144 acre.Pavement Length:	230.00 ft.
Pavement Width:	230.00 ft.
	Pavement slope 1:0.01 To 1
Pavement thickness:	0.5
Pour Space of Pavement:	0.4
Material thickness of second layer:	1
Pour Space of material for second layer:	0.33
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	3
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	458.321
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	458.321
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	30.165

Multifamily Phase 1 AND 2 Permeable Pavement

Pavement Area:0.9648 acre.Pavement Length:205.00 ft.

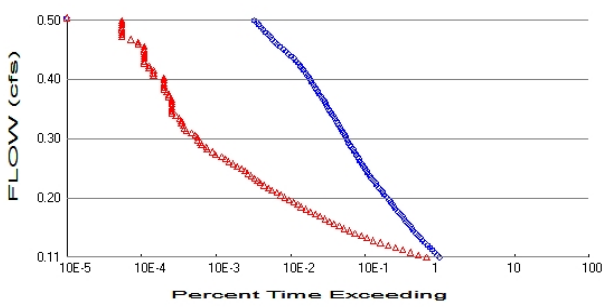
Pavement Width:	205.00 ft.
	Pavement slope 1:0.01 To 1
Pavement thickness:	0.5
Pour Space of Pavement:	0.4
Material thickness of second layer:	1
Pour Space of material for second layer:	0.33
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	3
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	364.785
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	364.785
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	23.968

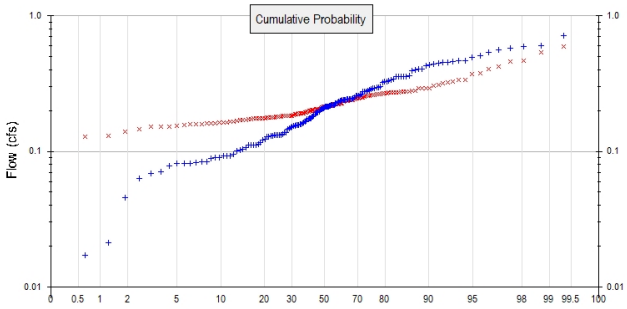
All Bypass Permeable Pavement

Pavement Area:0.0694 acre.Pavement Length:	55.00 ft.
Pavement Width:	55.00 ft.
	Pavement slope 1:0.01 To 1
Pavement thickness:	0.5
Pour Space of Pavement:	0.4
Material thickness of second layer:	1
Pour Space of material for second layer:	0.33
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	3
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	25.693
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	25.693
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	1.725

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 10.11
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 4.07
Total Impervious Area: 8.288622

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.213046
5 year	0.331437
10 year	0.395766
25 year	0.461241
50 year	0.500158
100 year	0.532159

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.211703
5 year	0.270069
10 year	0.312505
25 year	0.370539
50 year	0.417074
100 year	0.466534

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.156	0.215
1903	0.130	0.239
1904	0.213	0.272
1905	0.102	0.180
1906	0.046	0.152
1907	0.327	0.224
1908	0.242	0.176
1909	0.240	0.192
1910	0.330	0.227
1911	0.215	0.206

1912	0.709	0.459
1913	0.340	0.183
1914	0.083	0.592
1915	0.137	0.175
1916	0.213	0.258
1917	0.071	0.130
1918	0.228	0.197
1919	0.168	0.161
1920	0.217	0.199
1921	0.242	0.195
1922	0.243	0.238
1923	0.195	0.170
1924	0.089	0.242
1925	0.111	0.152
1926	0.206	0.203
1927	0.134	0.176
1928	0.165	0.174
1929	0.338	0.267
1930	0.217	0.274
1931	0.201	0.171
1932	0.157	0.178
1933	0.152	0.195
1934	0.446	0.274
1935	0.207	0.160
1936	0.180	0.206
1937	0.287	0.240
1938	0.175	0.170
1939	0.011	0.192
1940	0.194	0.276
1941	0.092	0.273
1942	0.292	0.239
1943	0.150	0.218
1944	0.276	0.327
1945	0.244	0.218
1946	0.132	0.206
1947	0.083	0.160
1948	0.458	0.225
1949	0.393	0.276
1950	0.111	0.165
1951	0.137	0.280
1952	0.598	0.338
1953	0.539	0.294
1954	0.195	0.179
1955	0.159	0.164
1956	0.078	0.154
1957	0.276	0.168
1958	0.577	0.265
1959	0.357	0.305
1960	0.095	0.175
1961	0.358	0.406
1962	0.192	0.190
1963	0.092	0.140
1964	0.101	0.420
1965	0.401	0.239
1966	0.112	0.162
1967	0.172	0.213
1968	0.176	0.188
1969	0.175	0.178

1970	0.275	0.212
1971	0.433	0.213
1972	0.281	0.537
1973	0.358	0.322
1974	0.194	0.234
1975	0.454	0.291
1976	0.240	0.259
1977	0.081	0.151
1978	0.404	0.263
1979	0.111	0.208
1980	0.229	0.237
1981	0.219	0.215
1982	0.090	0.184
1983	0.359	0.247
1984	0.146	0.227
1985	0.238	0.266
1986	0.213	0.176
1987	0.407	0.258
1988	0.258	0.179
1989	0.232	0.158
1990	0.262	0.188
1991	0.205	0.277
1992	0.294	0.250
1993	0.285	0.224
1994	0.427	0.205
1995	0.082	0.183
1996	0.468	0.252
1997	0.180	0.182
1998	0.214	0.215
1999	0.017	0.215
2000	0.163	0.203
2001	0.083	0.159
2002	0.297	0.279
2003	0.259	0.213
2004	0.238	0.233
2005	0.438	0.467
2006	0.132	0.202
2007	0.133	0.249
2008	0.226	0.182
2009	0.155	0.161
2010	0.132	0.216
2011	0.107	0.204
2012	0.155	0.193
2013	0.121	0.181
2014	0.090	0.177
2015	0.173	0.263
2016	0.069	0.198
2017	0.328	0.290
2018	0.597	0.317
2019	0.557	0.309
2020	0.182	0.210
2021	0.296	0.221
2022	0.122	0.261
2023	0.249	0.335
2024	0.468	0.372
2025	0.220	0.181
2026	0.358	0.273
2027	0.129	0.225

2028	0.112	0.120
2029	0.243	0.173
2030	0.451	0.260
2031	0.149	0.128
2032	0.081	0.165
2033	0.130	0.187
2034	0.128	0.164
2035	0.508	0.260
2036	0.264	0.186
2037	0.063	0.246
2038	0.210	0.215
2039	0.021	0.378
2040	0.117	0.184
2041	0.158	0.201
2042	0.494	0.245
2043	0.239	0.223
2044	0.322	0.226
2045	0.219	0.157
2046	0.257	0.198
2047	0.189	0.182
2048	0.245	0.178
2049	0.219	0.222
2050	0.157	0.190
2051	0.228	0.268
2052	0.131	0.205
2053	0.235	0.192
2054	0.298	0.293
2055	0.092	0.176
2056	0.104	0.235
2057	0.161	0.147
2058	0.204	0.249
2059	0.360	0.273

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.7092	0.5920
2	0.5976	0.5374
3	0.5970	0.4667
4	0.5767	0.4590
5	0.5568	0.4198
6	0.5391	0.4059
7	0.5082	0.3776
8	0.4944	0.3717
9	0.4682	0.3375
10	0.4675	0.3348
11	0.4583	0.3268
12	0.4541	0.3224
13	0.4505	0.3173
14	0.4461	0.3092
15	0.4380	0.3053
16	0.4326	0.2937
17	0.4272	0.2929
18	0.4067	0.2913
19	0.4043	0.2903
20	0.4012	0.2799
21	0.3927	0.2792
22	0.3605	0.2766

23	0.3585	0.2763
24	0.3584	0.2762
25	0.3584	0.2741
26	0.3575	0.2737
27	0.3565	0.2731
28	0.3398	0.2730
29	0.3384	0.2727
30	0.3302	0.2720
31	0.3283	0.2685
32	0.3270	0.2672
33	0.3222	0.2665
34	0.2984	0.2647
35	0.2970	0.2632
36	0.2957	0.2631
37	0.2938	0.2607
38	0.2923	0.2598
39	0.2874	0.2597
40	0.2849	0.2586
41	0.2805	0.2579
42	0.2761	0.2579
43	0.2755	0.2519
44	0.2748	0.2503
45	0.2639	0.2491
46	0.2624	0.2488
47	0.2586	0.2471
48	0.2579	0.2458
49	0.2570	0.2449
50	0.2487	0.2415
51	0.2448	0.2400
52	0.2435	0.2391
53	0.2430	0.2387
54	0.2429	0.2387
55	0.2423	0.2376
56	0.2422	0.2371
57	0.2404	0.2351
58	0.2395	0.2344
59	0.2388	0.2329
60	0.2379	0.2273
61	0.2377	0.2269
62	0.2347	0.2263
63	0.2318	0.2254
64	0.2289	0.2246
65	0.2281	0.2242
66	0.2276	0.2235
67	0.2263	0.2226
68	0.2195	0.2223
69	0.2194	0.2211
70	0.2192	0.2181
71	0.2189	0.2179
72	0.2175	0.2160
73	0.2167	0.2153
74	0.2150	0.2152
75	0.2137	0.2149
76	0.2132	0.2148
77	0.2127	0.2145
78	0.2126	0.2133
79	0.2105	0.2132
80	0.2071	0.2129

81	0.2063	0.2120
82	0.2054	0.2100
83	0.2041	0.2075
84	0.2012	0.2060
85	0.1954	0.2058
86	0.1945	0.2055
87	0.1941	0.2051
88	0.1935	0.2047
89	0.1925	0.2043
90	0.1892	0.2028
91	0.1816	0.2027
92	0.1800	0.2023
93	0.1796	0.2006
94	0.1758	0.1994
95	0.1755	0.1979
96	0.1751	0.1979
97	0.1726	0.1975
98	0.1723	0.1954
99	0.1683	0.1946
100	0.1651	0.1933
101	0.1625	0.1921
102	0.1612	0.1917
103	0.1590	0.1915
104	0.1577	0.1902
105	0.1575	0.1899
106	0.1571	0.1884
107	0.1562	0.1879
108	0.1553	0.1869
109	0.1549	0.1857
110	0.1519	0.1838
111	0.1504	0.1836
112	0.1489	0.1830
113	0.1461	0.1829
114	0.1369	0.1821
115	0.1369	0.1819
116	0.1338	0.1819
117	0.1329	0.1814
118	0.1325	0.1805
119	0.1322	0.1796
120	0.1317	0.1792
121	0.1312	0.1790
122	0.1303	0.1783
123	0.1300	0.1779
124	0.1288	0.1775
125	0.1282	0.1766
126	0.1224	0.1762
127	0.1209	0.1762
128	0.1170	0.1758
129	0.1125	0.1756
130	0.1116	0.1754
131	0.1113	0.1752
132	0.1109	0.1735
133	0.1108	0.1725
134	0.1068	0.1714
135	0.1037	0.1705
136	0.1023	0.1704
137	0.1015	0.1684
138	0.0948	0.1654

139	0.0925	0.1653
140	0.0924	0.1643
141	0.0922	0.1642
142	0.0901	0.1622
143	0.0896	0.1610
144	0.0893	0.1605
145	0.0832	0.1602
146	0.0832	0.1597
147	0.0830	0.1594
148	0.0820	0.1577
149	0.0810	0.1565
150	0.0809	0.1538
151	0.0779	0.1523
152	0.0709	0.1522
153	0.0687	0.1512
154	0.0631	0.1466
155	0.0458	0.1405
156	0.0211	0.1298
157	0.0172	0.1275
158	0.0110	0.1202

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1065	54847	36470	66	Pass
0.1105	50658	28404	56	Pass
0.1145	46980	22299	47	Pass
0.1185	43645	17507	40	Pass
0.1224	40570	14000	34	Pass
0.1264	37706	11119	29	Pass
0.1304	35135	8842	25	Pass
0.1344	32775	7086	21	Pass
0.1383	30509	5817	19	Pass
0.1423	28421	4856	17	Pass
0.1463	26537	4032	15	Pass
0.1503	24886	3422	13	Pass
0.1542	23379	2887	12	Pass
0.1582	21989	2482	11	Pass
0.1622	20687	2115	10	Pass
0.1662	19462	1834	9	Pass
0.1701	18315	1592	8	Pass
0.1741	17246	1362	7	Pass
0.1781	16177	1183	7	Pass
0.1821	15152	1018	6	Pass
0.1860	14277	884	6	Pass
0.1900	13451	766	5	Pass
0.1940	12875	692	5	Pass
0.1980	12099	605	5	Pass
0.2019	11407	530	4	Pass
0.2059	10726	461	4	Pass
0.2099	10094	410	4	Pass
0.2139	9501	360	3	Pass
0.2179	8969	307	3	Pass
0.2218	8426	278	3	Pass
0.2258	7944	245	3	Pass
0.2298	7534	216	2	Pass
0.2338	7108	199	2	Pass
0.2377	6687	182	2	Pass
0.2417	6327	163	2	Pass
0.2457	6028	148	2	Pass
0.2497	5751	134	2	Pass
0.2536	5478	121	2	Pass
0.2576	5226	106	2	Pass
0.2616	4980	94	1	Pass
0.2656	4725	82	1	Pass
0.2695	4533	74	1	Pass
0.2735	4356	66	1	Pass
0.2775	4177	54	1	Pass
0.2815	3975	50	1	Pass
0.2854	3785	42	1	Pass
0.2894	3595	41	1	Pass
0.2934	3430	35	1	Pass
0.2974	3275	34	1	Pass
0.3014	3141	31	0	Pass
0.3053	3033	31	1	Pass
0.3093	2935	29	0	Pass
0.3133	2816	26	0	Pass

0.3173	2685	22	0	Pass
0.3212	2560	21	0	Pass
0.3252	2457	20	0	Pass
0.3292	2363	19	0	Pass
0.3332	2257	19	0	Pass
0.3371	2143	18	0	Pass
0.3411	2041	16	0	Pass
0.3451	1952	14	0	Pass
0.3491	1860	14	0	Pass
0.3530	1778	14	0	Pass
0.3570	1688	14	0	Pass
0.3610	1633	14	0	Pass
0.3650	1577	14	0	Pass
0.3689	1501	14	0	Pass
0.3729	1426	13	0	Pass
0.3769	1354	13	0	Pass
0.3809	1285	12	0	Pass
0.3849	1227	11	0	Pass
0.3888	1173	11	0	Pass
0.3928	1113	11	0	Pass
0.3968	1069	11	1	Pass
0.4008	1018	11	1	Pass
0.4047	971	11	1	Pass
0.4087	925	8	0	Pass
0.4127	878	8	0	Pass
0.4167	818	8	0	Pass
0.4206	780	7	0	Pass
0.4246	742	7	0	Pass
0.4286	697	6	0	Pass
0.4326	648	6	0	Pass
0.4365	605	6	0	Pass
0.4405	559	6	1	Pass
0.4445	519	6	1	Pass
0.4485	482	6	1	Pass
0.4524	439	6	1	Pass
0.4564	396	6	1	Pass
0.4604	364	5	1	Pass
0.4644	342	5	1	Pass
0.4683	311	4	1	Pass
0.4723	297	3	1	Pass
0.4763	274	3	1	Pass
0.4803	253	3	1	Pass
0.4843	237	3	1	Pass
0.4882	224	3	1	Pass
0.4922	207	3	1	Pass
0.4962	195	3	1	Pass
0.5002	180	3	1	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
RTANK NW POC	☐	401.63			☐	0.00			
RTANK COMBINED POC	☐	1695.19			☐	0.00			
NW Commercial Permeable	☐	417.07			☐	100.00			
Multifamily Phase 1 AND 2	☐	331.95			☐	100.00			
All Bypass Permeable	☐	23.38			☐	100.00			
Total Volume Infiltrated		2869.22	0.00	0.00		26.92	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

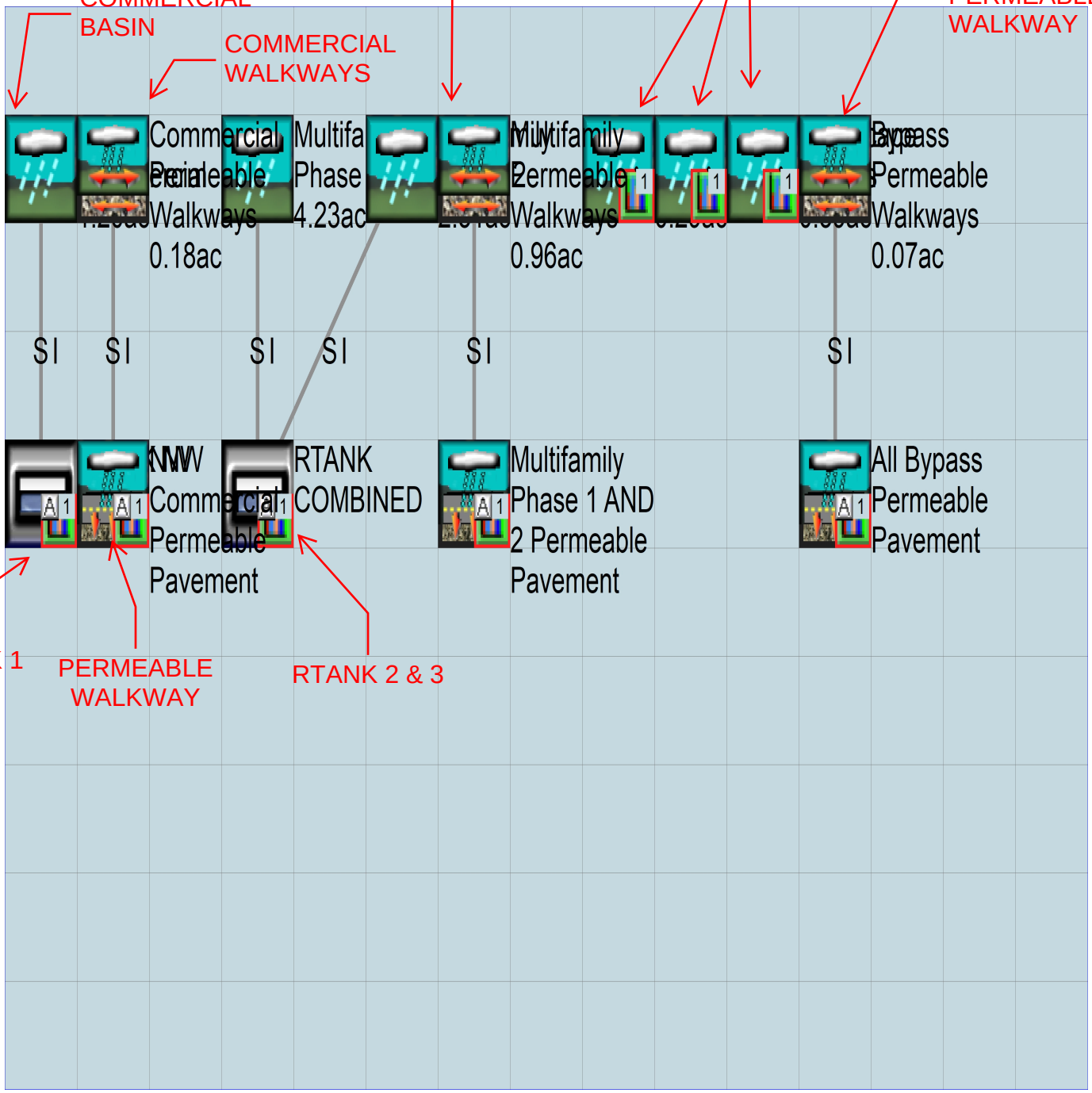
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   East Town Crossing Model 1 9.13.23.wdm
MESSU       25   PreEast Town Crossing Model 1 9.13.23.MES
            27   PreEast Town Crossing Model 1 9.13.23.L61
            28   PreEast Town Crossing Model 1 9.13.23.L62
            30   POCEast Town Crossing Model 1 9.13.231.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      10
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Landuse                    MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                       in  out           ***
   10     C, Forest, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10             0       4.5      0.08       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10             0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10           0.2       0.5      0.35         6       0.5       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   10             0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Landuse***
PERLND  10                       10.11     COPY   501     12
PERLND  10                       10.11     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM         26   East Town Crossing Model 1 9.13.23.wdm
MESSU       25   MitEast Town Crossing Model 1 9.13.23.MES
            27   MitEast Town Crossing Model 1 9.13.23.L61
            28   MitEast Town Crossing Model 1 9.13.23.L62
            30   POCEast Town Crossing Model 1 9.13.231.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       8
      IMPLND       2
      IMPLND       4
      PERLND       9
      PERLND      39
      PERLND      40
      PERLND      41
      RCHRES       1
      IMPLND      16
      RCHRES       2
      IMPLND      18
      RCHRES       3
      IMPLND      19
      RCHRES       4
      RCHRES       5
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        RTANK NW                    MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
```

```
                                          in  out           ***
  8     A/B, Lawn, Mod          1    1    1    1   27    0
  9     A/B, Lawn, Steep        1    1    1    1   27    0
 39     A/B, Pasture, Mod       1    1    1    1   27    0
 40     A/B, Lawn, Mod          1    1    1    1   27    0
 41     A/B, Lawn, Mod          1    1    1    1   27    0
END GEN-INFO
*** Section PWATER***

ACTIVITY
  <PLS > ************ Active Sections ******************************
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
  8         0    0    1    0    0    0    0    0    0    0    0    0
  9         0    0    1    0    0    0    0    0    0    0    0    0
 39         0    0    1    0    0    0    0    0    0    0    0    0
 40         0    0    1    0    0    0    0    0    0    0    0    0
 41         0    0    1    0    0    0    0    0    0    0    0    0
END ACTIVITY

PRINT-INFO
  <PLS > ***************** Print-flags ***************************** PIVL  PYR
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
  8         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  9         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 39         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 40         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 41         0    0    4    0    0    0    0    0    0    0    0    0    1    9
END PRINT-INFO

PWAT-PARM1
  <PLS >  PWATER variable monthly parameter value flags  ***
  # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
  8         0    0    0    0    0    0    0    0    0    0    0
  9         0    0    0    0    0    0    0    0    0    0    0
 39         0    0    0    0    0    0    0    0    0    0    0
 40         0    0    0    0    0    0    0    0    0    0    0
 41         0    0    0    0    0    0    0    0    0    0    0
END PWAT-PARM1

PWAT-PARM2
  <PLS >      PWATER input info: Part 2         ***
  # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  8              0         5       0.8       400       0.1       0.3     0.996
  9              0         5       0.8       400      0.15       0.3     0.996
 39              0         5       1.5       400       0.1       0.3     0.996
 40              0         5       0.8       400       0.1       0.3     0.996
 41              0         5       0.8       400       0.1       0.3     0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3         ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  8              0         0         2         2         0         0         0
  9              0         0         2         2         0         0         0
 39              0         0         2         2         0         0         0
 40              0         0         2         2         0         0         0
 41              0         0         2         2         0         0         0
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                          ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  8          0.1       0.5      0.25         0       0.7      0.25
  9          0.1       0.5      0.25         0       0.7      0.25
 39         0.15       0.5       0.3         0       0.7       0.4
 40          0.1       0.5      0.25         0       0.7      0.25
 41          0.1       0.5      0.25         0       0.7      0.25
END PWAT-PARM4

PWAT-STATE1
  <PLS > *** Initial conditions at start of simulation
```

```
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
    8             0         0         0          0         3          1          0
    9             0         0         0          0         3          1          0
   39             0         0         0          0         3          1          0
   40             0         0         0          0         3          1          0
   41             0         0         0          0         3          1          0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
   16      Porous Pavement        1    1    1   27    0
   18      Porous Pavement        1    1    1   27    0
   19      Porous Pavement        1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
   16         0    0    1    0    0    0
   18         0    0    1    0    0    0
   19         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL     *********
    2         0    0    4    0    0    4     1    9
    4         0    0    4    0    0    0     1    9
   16         0    0    4    0    0    0     1    9
   18         0    0    4    0    0    0     1    9
   19         0    0    4    0    0    0     1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
   16         0    0    0    0    0
   18         0    0    0    0    0
   19         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2          400      0.05       0.1      0.08
    4          400      0.01       0.1       0.1
   16          400      0.01       0.1       0.1
   18          400      0.01       0.1       0.1
   19          400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2             0         0
    4             0         0
   16             0         0
```

```
   18              0         0
   19              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
   16              0         0
   18              0         0
   19              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Multifamily Phase 1***
PERLND   8                        1.18     RCHRES   5      2
PERLND   8                        1.18     RCHRES   5      3
IMPLND   2                        1.86     RCHRES   5      5
IMPLND   4                        1.19     RCHRES   5      5
NW Commercial***
PERLND   8                        0.12     RCHRES   1      2
PERLND   8                        0.12     RCHRES   1      3
IMPLND   2                        0.84     RCHRES   1      5
IMPLND   4                        0.24     RCHRES   1      5
Multifamily Phase 2***
PERLND   8                        0.99     RCHRES   5      2
PERLND   8                        0.99     RCHRES   5      3
IMPLND   2                         0.9     RCHRES   5      5
IMPLND   4                        0.62     RCHRES   5      5
IMPLND  16                      1.2144     RCHRES   2      5
Commercial Permeable Walkways***
PERLND  39                      0.1482     IMPLND  16     54
PERLND  39                      0.1482     IMPLND  16     55
Multifamily Permeable Walkways***
PERLND  40                      0.9951     IMPLND  18     54
PERLND  40                      0.9951     IMPLND  18     55
IMPLND  18                      0.9648     RCHRES   3      5
Bypass Permeable Walkways***
PERLND  41                       1.008     IMPLND  19     54
PERLND  41                       1.008     IMPLND  19     55
IMPLND  19                      0.0694     RCHRES   4      5
Shaw Road Bypass***
PERLND   8                        0.18     COPY   501     12
PERLND   8                        0.18     COPY   601     12
PERLND   8                        0.18     COPY   501     13
PERLND   8                        0.18     COPY   601     13
IMPLND   2                        0.11     COPY   501     15
IMPLND   2                        0.11     COPY   601     15
Pioneer Road Bypass***
IMPLND   2                        0.28     COPY   501     15
IMPLND   2                        0.28     COPY   601     15
Landscape Bypass***
PERLND   9                        0.39     COPY   501     12
PERLND   9                        0.39     COPY   601     12
PERLND   9                        0.39     COPY   501     13
PERLND   9                        0.39     COPY   601     13

******Routing******
PERLND   8                        1.18     COPY     1     12
IMPLND   2                        1.86     COPY     1     15
IMPLND   4                        1.19     COPY     1     15
PERLND   8                        1.18     COPY     1     13
PERLND   8                        0.12     COPY     1     12
IMPLND   2                        0.84     COPY     1     15
IMPLND   4                        0.24     COPY     1     15
```

```
PERLND   8                        0.12     COPY     1     13
PERLND   8                        0.99     COPY     1     12
IMPLND   2                         0.9     COPY     1     15
IMPLND   4                        0.62     COPY     1     15
PERLND   8                        0.99     COPY     1     13
PERLND  39                        0.18     COPY     1     12
PERLND  39                        0.18     COPY     1     13
PERLND  40                        0.96     COPY     1     12
PERLND  40                        0.96     COPY     1     13
PERLND  41                        0.07     COPY     1     12
PERLND  41                        0.07     COPY     1     13
RCHRES   1                           1     COPY   501     16
RCHRES   5                           1     COPY   501     16
RCHRES   2                           1     COPY   501     17
RCHRES   3                           1     COPY   501     17
RCHRES   4                           1     COPY   501     17
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<----------------><---> User T-series  Engl Metr LKFG             ***
                                       in  out                              ***
    1     RTANK NW                 1    1    1    1   28    0    1
    2     NW Commercial Pe-016     2    1    1    1   28    0    1
    3     Multifamily Phas-019     2    1    1    1   28    0    1
    4     All Bypass Perme-022     2    1    1    1   28    0    1
    5     RTANK COMBINED           1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
    4         1    0    0    0    0    0    0    0    0    0
    5         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
    4         4    0    0    0    0    0    0    0    0    0    1    9
    5         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                   ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
           FG FG FG FG  possible  exit  *** possible  exit      possible  exit
            *  *  *  *     *  *  *  *  *      *  *  *  *  *        ***
    1       0  1  0  0     4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    2       0  1  0  0     4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    3       0  1  0  0     4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
```

```
    4        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    5        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50        ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1              1      0.02       0.0       0.0       0.5       0.0
    2              2      0.04       0.0       0.0       0.5       0.0
    3              3      0.04       0.0       0.0       0.5       0.0
    4              4      0.01       0.0       0.0       0.5       0.0
    5              5      0.03       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                          ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    4            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    5            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.382025  0.000000  0.000000
  0.033333  0.382025  0.012734  0.002093
  0.066667  0.382025  0.025468  0.002960
  0.100000  0.382025  0.038202  0.003626
  0.133333  0.382025  0.050937  0.004187
  0.166667  0.382025  0.063671  0.004681
  0.200000  0.382025  0.076405  0.005127
  0.233333  0.382025  0.089139  0.005538
  0.266667  0.382025  0.101873  0.005921
  0.300000  0.382025  0.114607  0.006280
  0.333333  0.382025  0.127342  0.006619
  0.366667  0.382025  0.140076  0.006943
  0.400000  0.382025  0.152810  0.007251
  0.433333  0.382025  0.165544  0.007547
  0.466667  0.382025  0.178278  0.007832
  0.500000  0.382025  0.191012  0.008107
  0.533333  0.382025  0.203747  0.008373
  0.566667  0.382025  0.216481  0.008631
  0.600000  0.382025  0.229215  0.008881
  0.633333  0.382025  0.241949  0.009124
  0.666667  0.382025  0.254683  0.009361
  0.700000  0.382025  0.267417  0.009593
  0.733333  0.382025  0.280152  0.009818
  0.766667  0.382025  0.292886  0.010039
  0.800000  0.382025  0.305620  0.010255
  0.833333  0.382025  0.318354  0.010466
  0.866667  0.382025  0.331088  0.010674
  0.900000  0.382025  0.343822  0.010877
  0.933333  0.382025  0.356556  0.011077
  0.966667  0.382025  0.369291  0.011273
  1.000000  0.382025  0.382025  0.011465
  1.033333  0.382025  0.394759  0.011655
  1.066667  0.382025  0.407493  0.011841
  1.100000  0.382025  0.420227  0.012025
  1.133333  0.382025  0.432961  0.012206
  1.166667  0.382025  0.445696  0.012384
  1.200000  0.382025  0.458430  0.012560
```

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1.233333  0.382025  0.471164  0.012733
1.266667  0.382025  0.483898  0.012904
1.300000  0.382025  0.496632  0.013072
1.333333  0.382025  0.509366  0.013239
1.366667  0.382025  0.522101  0.013403
1.400000  0.382025  0.534835  0.013566
1.433333  0.382025  0.547569  0.013726
1.466667  0.382025  0.560303  0.013885
1.500000  0.382025  0.573037  0.014042
1.533333  0.382025  0.585771  0.014197
1.566667  0.382025  0.598506  0.014351
1.600000  0.382025  0.611240  0.014503
1.633333  0.382025  0.623974  0.014653
1.666667  0.382025  0.636708  0.014802
1.700000  0.382025  0.649442  0.014949
1.733333  0.382025  0.662176  0.015095
1.766667  0.382025  0.674910  0.015239
1.800000  0.382025  0.687645  0.015382
1.833333  0.382025  0.700379  0.015524
1.866667  0.382025  0.713113  0.015665
1.900000  0.382025  0.725847  0.015804
1.933333  0.382025  0.738581  0.015942
1.966667  0.382025  0.751315  0.016079
2.000000  0.382025  0.764050  0.016214
2.033333  0.382025  0.776784  0.024737
2.066667  0.382025  0.789518  0.040047
2.100000  0.382025  0.802252  0.059614
2.133333  0.382025  0.814986  0.082497
2.166667  0.382025  0.827720  0.108137
2.200000  0.382025  0.840455  0.136143
2.233333  0.382025  0.853189  0.166222
2.266667  0.382025  0.865923  0.198138
2.300000  0.382025  0.878657  0.231698
2.333333  0.382025  0.891391  0.266736
2.366667  0.382025  0.904125  0.303110
2.400000  0.382025  0.916860  0.340694
2.433333  0.382025  0.929594  0.379374
2.466667  0.382025  0.942328  0.419050
2.500000  0.382025  0.955062  0.459628
2.533333  0.382025  0.967796  0.501024
2.566667  0.382025  0.980530  0.543158
2.600000  0.382025  0.993264  0.585957
2.633333  0.382025  1.005999  0.629353
2.666667  0.382025  1.018733  0.673281
2.700000  0.382025  1.031467  0.717681
2.733333  0.382025  1.044201  0.762494
2.766667  0.382025  1.056935  0.807668
2.800000  0.382025  1.069669  0.853149
2.833333  0.382025  1.082404  0.898888
2.866667  0.382025  1.095138  0.944838
2.900000  0.382025  1.107872  0.990953
2.933333  0.382025  1.120606  1.037189
2.966667  0.382025  1.133340  1.083504
3.000000  0.382025  1.146074  1.129858
3.033333  0.382025  1.158809  1.183738
END FTABLE  1
FTABLE      5
 92    4
   Depth      Area    Volume  Outflow1 Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
0.000000  0.644077  0.000000  0.000000
0.055556  0.644077  0.035782  0.015666
0.111111  0.644077  0.071564  0.022155
0.166667  0.644077  0.107346  0.027134
0.222222  0.644077  0.143128  0.031331
0.277778  0.644077  0.178910  0.035030
0.333333  0.644077  0.214692  0.038373
0.388889  0.644077  0.250474  0.041448
0.444444  0.644077  0.286257  0.044309
0.500000  0.644077  0.322039  0.046997
```

0.555556	0.644077	0.357821	0.049539
0.611111	0.644077	0.393603	0.051957
0.666667	0.644077	0.429385	0.054268
0.722222	0.644077	0.465167	0.056484
0.777778	0.644077	0.500949	0.058616
0.833333	0.644077	0.536731	0.060673
0.888889	0.644077	0.572513	0.062663
0.944444	0.644077	0.608295	0.064592
1.000000	0.644077	0.644077	0.066464
1.055556	0.644077	0.679859	0.068285
1.111111	0.644077	0.715641	0.070059
1.166667	0.644077	0.751423	0.071789
1.222222	0.644077	0.787205	0.073479
1.277778	0.644077	0.822987	0.075130
1.333333	0.644077	0.858770	0.076746
1.388889	0.644077	0.894552	0.078329
1.444444	0.644077	0.930334	0.079880
1.500000	0.644077	0.966116	0.081402
1.555556	0.644077	1.001898	0.082895
1.611111	0.644077	1.037680	0.084363
1.666667	0.644077	1.073462	0.085805
1.722222	0.644077	1.109244	0.087223
1.777778	0.644077	1.145026	0.088619
1.833333	0.644077	1.180808	0.089993
1.888889	0.644077	1.216590	0.091346
1.944444	0.644077	1.252372	0.092680
2.000000	0.644077	1.288154	0.093994
2.055556	0.644077	1.323936	0.095291
2.111111	0.644077	1.359718	0.096570
2.166667	0.644077	1.395500	0.097833
2.222222	0.644077	1.431283	0.099079
2.277778	0.644077	1.467065	0.100310
2.333333	0.644077	1.502847	0.101526
2.388889	0.644077	1.538629	0.102727
2.444444	0.644077	1.574411	0.103915
2.500000	0.644077	1.610193	0.105089
2.555556	0.644077	1.645975	0.106250
2.611111	0.644077	1.681757	0.107399
2.666667	0.644077	1.717539	0.108535
2.722222	0.644077	1.753321	0.109660
2.777778	0.644077	1.789103	0.110774
2.833333	0.644077	1.824885	0.111876
2.888889	0.644077	1.860667	0.112967
2.944444	0.644077	1.896449	0.114048
3.000000	0.644077	1.932231	0.115119
3.055556	0.644077	1.968013	0.116180
3.111111	0.644077	2.003796	0.117232
3.166667	0.644077	2.039578	0.118274
3.222222	0.644077	2.075360	0.124798
3.277778	0.644077	2.111142	0.155885
3.333333	0.644077	2.146924	0.200248
3.388889	0.644077	2.182706	0.253876
3.444444	0.644077	2.218488	0.314741
3.500000	0.644077	2.254270	0.381515
3.555556	0.644077	2.290052	0.453224
3.611111	0.644077	2.325834	0.529102
3.666667	0.644077	2.361616	0.608521
3.722222	0.644077	2.397398	0.690946
3.777778	0.644077	2.433180	0.775918
3.833333	0.644077	2.468962	0.863026
3.888889	0.644077	2.504744	0.951907
3.944444	0.644077	2.540526	1.042227
4.000000	0.644077	2.576309	1.133685
4.055556	0.644077	2.612091	1.226000
4.111111	0.644077	2.647873	1.318911
4.166667	0.644077	2.683655	1.412177
4.222222	0.644077	2.719437	1.513217
4.277778	0.644077	2.755219	1.627850
4.333333	0.644077	2.791001	1.745448
4.388889	0.644077	2.826783	1.865937

```
4.444444  0.644077  2.862565  1.989249
4.500000  0.644077  2.898347  2.115320
4.555556  0.644077  2.934129  2.244089
4.611111  0.644077  2.969911  3.090512
4.666667  0.644077  3.005693  3.267153
4.722222  0.644077  3.041475  3.447151
4.777778  0.644077  3.077257  3.630444
4.833333  0.644077  3.113039  3.816973
4.888889  0.644077  3.148822  4.006682
4.944444  0.644077  3.184604  4.199520
5.000000  0.644077  3.220386  4.395435
5.055556  0.644077  3.256168  4.604529
END FTABLE  5
FTABLE      2
 91    5
   Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
0.000000  1.214417  0.000000  0.000000  0.000000
0.011111  1.214417  0.004453  0.000000  3.673611
0.022222  1.214417  0.008906  0.000000  3.673611
0.033333  1.214417  0.013359  0.000000  3.673611
0.044444  1.214417  0.017811  0.000000  3.673611
0.055556  1.214417  0.022264  0.000000  3.673611
0.066667  1.214417  0.026717  0.000000  3.673611
0.077778  1.214417  0.031170  0.000000  3.673611
0.088889  1.214417  0.035623  0.000000  3.673611
0.100000  1.214417  0.040076  0.000000  3.673611
0.111111  1.214417  0.044529  0.000000  3.673611
0.122222  1.214417  0.048981  0.000000  3.673611
0.133333  1.214417  0.053434  0.000000  3.673611
0.144444  1.214417  0.057887  0.000000  3.673611
0.155556  1.214417  0.062340  0.000000  3.673611
0.166667  1.214417  0.066793  0.000000  3.673611
0.177778  1.214417  0.071246  0.000000  3.673611
0.188889  1.214417  0.075699  0.000000  3.673611
0.200000  1.214417  0.080152  0.000000  3.673611
0.211111  1.214417  0.084604  0.000000  3.673611
0.222222  1.214417  0.089057  0.000000  3.673611
0.233333  1.214417  0.093510  0.000000  3.673611
0.244444  1.214417  0.097963  0.000000  3.673611
0.255556  1.214417  0.102416  0.000000  3.673611
0.266667  1.214417  0.106869  0.000000  3.673611
0.277778  1.214417  0.111322  0.000000  3.673611
0.288889  1.214417  0.115774  0.000000  3.673611
0.300000  1.214417  0.120227  0.000000  3.673611
0.311111  1.214417  0.124680  0.000000  3.673611
0.322222  1.214417  0.129133  0.000000  3.673611
0.333333  1.214417  0.133586  0.000000  3.673611
0.344444  1.214417  0.138039  0.000000  3.673611
0.355556  1.214417  0.142492  0.000000  3.673611
0.366667  1.214417  0.146944  0.000000  3.673611
0.377778  1.214417  0.151397  0.000000  3.673611
0.388889  1.214417  0.155850  0.000000  3.673611
0.400000  1.214417  0.160303  0.000000  3.673611
0.411111  1.214417  0.164756  0.000000  3.673611
0.422222  1.214417  0.169209  0.000000  3.673611
0.433333  1.214417  0.173662  0.000000  3.673611
0.444444  1.214417  0.178114  0.000000  3.673611
0.455556  1.214417  0.182567  0.000000  3.673611
0.466667  1.214417  0.187020  0.000000  3.673611
0.477778  1.214417  0.191473  0.000000  3.673611
0.488889  1.214417  0.195926  0.000000  3.673611
0.500000  1.214417  0.200379  0.000000  3.673611
0.511111  1.214417  0.204832  0.000000  3.673611
0.522222  1.214417  0.209285  0.000000  3.673611
0.533333  1.214417  0.213737  0.000000  3.673611
0.544444  1.214417  0.218190  0.000000  3.673611
0.555556  1.214417  0.222643  0.000000  3.673611
0.566667  1.214417  0.227096  0.000000  3.673611
0.577778  1.214417  0.231549  0.000000  3.673611
```

```
0.588889  1.214417  0.236002  0.000000  3.673611
0.600000  1.214417  0.240455  0.000000  3.673611
0.611111  1.214417  0.244907  0.000000  3.673611
0.622222  1.214417  0.249360  0.000000  3.673611
0.633333  1.214417  0.253813  0.000000  3.673611
0.644444  1.214417  0.258266  0.000000  3.673611
0.655556  1.214417  0.262719  0.000000  3.673611
0.666667  1.214417  0.267172  0.000000  3.673611
0.677778  1.214417  0.271625  0.000000  3.673611
0.688889  1.214417  0.276077  0.000000  3.673611
0.700000  1.214417  0.280530  0.000000  3.673611
0.711111  1.214417  0.284983  0.000000  3.673611
0.722222  1.214417  0.289436  0.000000  3.673611
0.733333  1.214417  0.293889  0.000000  3.673611
0.744444  1.214417  0.298342  0.000000  3.673611
0.755556  1.214417  0.302795  0.000000  3.673611
0.766667  1.214417  0.307247  0.000000  3.673611
0.777778  1.214417  0.311700  0.000000  3.673611
0.788889  1.214417  0.316153  0.000000  3.673611
0.800000  1.214417  0.320606  0.000000  3.673611
0.811111  1.214417  0.325059  0.000000  3.673611
0.822222  1.214417  0.329512  0.000000  3.673611
0.833333  1.214417  0.333965  0.000000  3.673611
0.844444  1.214417  0.338418  0.000000  3.673611
0.855556  1.214417  0.342870  0.000000  3.673611
0.866667  1.214417  0.347323  0.000000  3.673611
0.877778  1.214417  0.351776  0.000000  3.673611
0.888889  1.214417  0.356229  0.000000  3.673611
0.900000  1.214417  0.360682  0.000000  3.673611
0.911111  1.214417  0.365135  0.000000  3.673611
0.922222  1.214417  0.369588  0.000000  3.673611
0.933333  1.214417  0.374040  0.000000  3.673611
0.944444  1.214417  0.378493  0.000000  3.673611
0.955556  1.214417  0.382946  0.000000  3.673611
0.966667  1.214417  0.387399  0.000000  3.673611
0.977778  1.214417  0.391852  0.000000  3.673611
0.988889  1.214417  0.396305  0.000000  3.673611
1.000000  1.214417  0.400758  0.000000  3.673611
END FTABLE  2
FTABLE      3
 91    5
   Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
0.000000  0.964761  0.000000  0.000000  0.000000
0.011111  0.964761  0.003537  0.000000  2.918403
0.022222  0.964761  0.007075  0.000000  2.918403
0.033333  0.964761  0.010612  0.000000  2.918403
0.044444  0.964761  0.014150  0.000000  2.918403
0.055556  0.964761  0.017687  0.000000  2.918403
0.066667  0.964761  0.021225  0.000000  2.918403
0.077778  0.964761  0.024762  0.000000  2.918403
0.088889  0.964761  0.028300  0.000000  2.918403
0.100000  0.964761  0.031837  0.000000  2.918403
0.111111  0.964761  0.035375  0.000000  2.918403
0.122222  0.964761  0.038912  0.000000  2.918403
0.133333  0.964761  0.042449  0.000000  2.918403
0.144444  0.964761  0.045987  0.000000  2.918403
0.155556  0.964761  0.049524  0.000000  2.918403
0.166667  0.964761  0.053062  0.000000  2.918403
0.177778  0.964761  0.056599  0.000000  2.918403
0.188889  0.964761  0.060137  0.000000  2.918403
0.200000  0.964761  0.063674  0.000000  2.918403
0.211111  0.964761  0.067212  0.000000  2.918403
0.222222  0.964761  0.070749  0.000000  2.918403
0.233333  0.964761  0.074287  0.000000  2.918403
0.244444  0.964761  0.077824  0.000000  2.918403
0.255556  0.964761  0.081362  0.000000  2.918403
0.266667  0.964761  0.084899  0.000000  2.918403
0.277778  0.964761  0.088436  0.000000  2.918403
0.288889  0.964761  0.091974  0.000000  2.918403
```

```
0.300000  0.964761  0.095511  0.000000  2.918403
0.311111  0.964761  0.099049  0.000000  2.918403
0.322222  0.964761  0.102586  0.000000  2.918403
0.333333  0.964761  0.106124  0.000000  2.918403
0.344444  0.964761  0.109661  0.000000  2.918403
0.355556  0.964761  0.113199  0.000000  2.918403
0.366667  0.964761  0.116736  0.000000  2.918403
0.377778  0.964761  0.120274  0.000000  2.918403
0.388889  0.964761  0.123811  0.000000  2.918403
0.400000  0.964761  0.127348  0.000000  2.918403
0.411111  0.964761  0.130886  0.000000  2.918403
0.422222  0.964761  0.134423  0.000000  2.918403
0.433333  0.964761  0.137961  0.000000  2.918403
0.444444  0.964761  0.141498  0.000000  2.918403
0.455556  0.964761  0.145036  0.000000  2.918403
0.466667  0.964761  0.148573  0.000000  2.918403
0.477778  0.964761  0.152111  0.000000  2.918403
0.488889  0.964761  0.155648  0.000000  2.918403
0.500000  0.964761  0.159186  0.000000  2.918403
0.511111  0.964761  0.162723  0.000000  2.918403
0.522222  0.964761  0.166261  0.000000  2.918403
0.533333  0.964761  0.169798  0.000000  2.918403
0.544444  0.964761  0.173335  0.000000  2.918403
0.555556  0.964761  0.176873  0.000000  2.918403
0.566667  0.964761  0.180410  0.000000  2.918403
0.577778  0.964761  0.183948  0.000000  2.918403
0.588889  0.964761  0.187485  0.000000  2.918403
0.600000  0.964761  0.191023  0.000000  2.918403
0.611111  0.964761  0.194560  0.000000  2.918403
0.622222  0.964761  0.198098  0.000000  2.918403
0.633333  0.964761  0.201635  0.000000  2.918403
0.644444  0.964761  0.205173  0.000000  2.918403
0.655556  0.964761  0.208710  0.000000  2.918403
0.666667  0.964761  0.212247  0.000000  2.918403
0.677778  0.964761  0.215785  0.000000  2.918403
0.688889  0.964761  0.219322  0.000000  2.918403
0.700000  0.964761  0.222860  0.000000  2.918403
0.711111  0.964761  0.226397  0.000000  2.918403
0.722222  0.964761  0.229935  0.000000  2.918403
0.733333  0.964761  0.233472  0.000000  2.918403
0.744444  0.964761  0.237010  0.000000  2.918403
0.755556  0.964761  0.240547  0.000000  2.918403
0.766667  0.964761  0.244085  0.000000  2.918403
0.777778  0.964761  0.247622  0.000000  2.918403
0.788889  0.964761  0.251160  0.000000  2.918403
0.800000  0.964761  0.254697  0.000000  2.918403
0.811111  0.964761  0.258234  0.000000  2.918403
0.822222  0.964761  0.261772  0.000000  2.918403
0.833333  0.964761  0.265309  0.000000  2.918403
0.844444  0.964761  0.268847  0.000000  2.918403
0.855556  0.964761  0.272384  0.000000  2.918403
0.866667  0.964761  0.275922  0.000000  2.918403
0.877778  0.964761  0.279459  0.000000  2.918403
0.888889  0.964761  0.282997  0.000000  2.918403
0.900000  0.964761  0.286534  0.000000  2.918403
0.911111  0.964761  0.290072  0.000000  2.918403
0.922222  0.964761  0.293609  0.000000  2.918403
0.933333  0.964761  0.297146  0.000000  2.918403
0.944444  0.964761  0.300684  0.000000  2.918403
0.955556  0.964761  0.304221  0.000000  2.918403
0.966667  0.964761  0.307759  0.000000  2.918403
0.977778  0.964761  0.311296  0.000000  2.918403
0.988889  0.964761  0.314834  0.000000  2.918403
1.000000  0.964761  0.318371  0.000000  2.918403
END FTABLE  3
FTABLE      4
 91    5
   Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
0.000000  0.069444  0.000000  0.000000  0.000000
```

0.011111	0.069444	0.000255	0.000000	0.210069
0.022222	0.069444	0.000509	0.000000	0.210069
0.033333	0.069444	0.000764	0.000000	0.210069
0.044444	0.069444	0.001019	0.000000	0.210069
0.055556	0.069444	0.001273	0.000000	0.210069
0.066667	0.069444	0.001528	0.000000	0.210069
0.077778	0.069444	0.001782	0.000000	0.210069
0.088889	0.069444	0.002037	0.000000	0.210069
0.100000	0.069444	0.002292	0.000000	0.210069
0.111111	0.069444	0.002546	0.000000	0.210069
0.122222	0.069444	0.002801	0.000000	0.210069
0.133333	0.069444	0.003056	0.000000	0.210069
0.144444	0.069444	0.003310	0.000000	0.210069
0.155556	0.069444	0.003565	0.000000	0.210069
0.166667	0.069444	0.003819	0.000000	0.210069
0.177778	0.069444	0.004074	0.000000	0.210069
0.188889	0.069444	0.004329	0.000000	0.210069
0.200000	0.069444	0.004583	0.000000	0.210069
0.211111	0.069444	0.004838	0.000000	0.210069
0.222222	0.069444	0.005093	0.000000	0.210069
0.233333	0.069444	0.005347	0.000000	0.210069
0.244444	0.069444	0.005602	0.000000	0.210069
0.255556	0.069444	0.005856	0.000000	0.210069
0.266667	0.069444	0.006111	0.000000	0.210069
0.277778	0.069444	0.006366	0.000000	0.210069
0.288889	0.069444	0.006620	0.000000	0.210069
0.300000	0.069444	0.006875	0.000000	0.210069
0.311111	0.069444	0.007130	0.000000	0.210069
0.322222	0.069444	0.007384	0.000000	0.210069
0.333333	0.069444	0.007639	0.000000	0.210069
0.344444	0.069444	0.007894	0.000000	0.210069
0.355556	0.069444	0.008148	0.000000	0.210069
0.366667	0.069444	0.008403	0.000000	0.210069
0.377778	0.069444	0.008657	0.000000	0.210069
0.388889	0.069444	0.008912	0.000000	0.210069
0.400000	0.069444	0.009167	0.000000	0.210069
0.411111	0.069444	0.009421	0.000000	0.210069
0.422222	0.069444	0.009676	0.000000	0.210069
0.433333	0.069444	0.009931	0.000000	0.210069
0.444444	0.069444	0.010185	0.000000	0.210069
0.455556	0.069444	0.010440	0.000000	0.210069
0.466667	0.069444	0.010694	0.000000	0.210069
0.477778	0.069444	0.010949	0.000000	0.210069
0.488889	0.069444	0.011204	0.000000	0.210069
0.500000	0.069444	0.011458	0.000000	0.210069
0.511111	0.069444	0.011713	0.000000	0.210069
0.522222	0.069444	0.011968	0.000000	0.210069
0.533333	0.069444	0.012222	0.000000	0.210069
0.544444	0.069444	0.012477	0.000000	0.210069
0.555556	0.069444	0.012731	0.000000	0.210069
0.566667	0.069444	0.012986	0.000000	0.210069
0.577778	0.069444	0.013241	0.000000	0.210069
0.588889	0.069444	0.013495	0.000000	0.210069
0.600000	0.069444	0.013750	0.000000	0.210069
0.611111	0.069444	0.014005	0.000000	0.210069
0.622222	0.069444	0.014259	0.000000	0.210069
0.633333	0.069444	0.014514	0.000000	0.210069
0.644444	0.069444	0.014769	0.000000	0.210069
0.655556	0.069444	0.015023	0.000000	0.210069
0.666667	0.069444	0.015278	0.000000	0.210069
0.677778	0.069444	0.015532	0.000000	0.210069
0.688889	0.069444	0.015787	0.000000	0.210069
0.700000	0.069444	0.016042	0.000000	0.210069
0.711111	0.069444	0.016296	0.000000	0.210069
0.722222	0.069444	0.016551	0.000000	0.210069
0.733333	0.069444	0.016806	0.000000	0.210069
0.744444	0.069444	0.017060	0.000000	0.210069
0.755556	0.069444	0.017315	0.000000	0.210069
0.766667	0.069444	0.017569	0.000000	0.210069
0.777778	0.069444	0.017824	0.000000	0.210069

```
  0.788889  0.069444  0.018079  0.000000  0.210069
  0.800000  0.069444  0.018333  0.000000  0.210069
  0.811111  0.069444  0.018588  0.000000  0.210069
  0.822222  0.069444  0.018843  0.000000  0.210069
  0.833333  0.069444  0.019097  0.000000  0.210069
  0.844444  0.069444  0.019352  0.000000  0.210069
  0.855556  0.069444  0.019606  0.000000  0.210069
  0.866667  0.069444  0.019861  0.000000  0.210069
  0.877778  0.069444  0.020116  0.000000  0.210069
  0.888889  0.069444  0.020370  0.000000  0.210069
  0.900000  0.069444  0.020625  0.000000  0.210069
  0.911111  0.069444  0.020880  0.000000  0.210069
  0.922222  0.069444  0.021134  0.000000  0.210069
  0.933333  0.069444  0.021389  0.000000  0.210069
  0.944444  0.069444  0.021644  0.000000  0.210069
  0.955556  0.069444  0.021898  0.000000  0.210069
  0.966667  0.069444  0.022153  0.000000  0.210069
  0.977778  0.069444  0.022407  0.000000  0.210069
  0.988889  0.069444  0.022662  0.000000  0.210069
  1.000000  0.069444  0.022917  0.000000  0.210069
  END FTABLE  4
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              RCHRES   2     EXTNL  POTEV
WDM      1 EVAP     ENGL    1              RCHRES   3     EXTNL  POTEV
WDM      1 EVAP     ENGL    1              RCHRES   4     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
RCHRES   5 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   5 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
RCHRES   2 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1005 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1006 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1007 STAG     ENGL      REPL
RCHRES   3 HYDR   RO     1 1        1      WDM   1008 FLOW     ENGL      REPL
RCHRES   3 HYDR   O      1 1        1      WDM   1009 FLOW     ENGL      REPL
RCHRES   3 HYDR   O      2 1        1      WDM   1010 FLOW     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1011 STAG     ENGL      REPL
RCHRES   4 HYDR   RO     1 1        1      WDM   1012 FLOW     ENGL      REPL
RCHRES   4 HYDR   O      1 1        1      WDM   1013 FLOW     ENGL      REPL
RCHRES   4 HYDR   O      2 1        1      WDM   1014 FLOW     ENGL      REPL
RCHRES   4 HYDR   STAGE  1 1        1      WDM   1015 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>             <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3
```

```
  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17

  MASS-LINK       54
PERLND     PWATER SURO                     IMPLND         EXTNL  SURLI
  END MASS-LINK   54

  MASS-LINK       55
PERLND     PWATER IFWO                     IMPLND         EXTNL  SURLI
  END MASS-LINK   55


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1964/ 9/30 24: 0

RCHRES :    1

RELERR       STORS        STOR       MATIN      MATDIF
-0.05840     0.00000  0.0000E+00     0.00000  -6.091E-09

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

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ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1966/ 8/31 24: 0

RCHRES :    1

RELERR       STORS        STOR       MATIN      MATDIF
-4.801E-02     0.00000  0.0000E+00     0.00000  -7.505E-09

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
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ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
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DATE/TIME: 1989/ 8/31 24: 0

RCHRES :   1

RELERR	STORS	STOR	MATIN	MATDIF
-2.073E-03	0.00000	0.0000E+00	0.00000	-1.825E-07

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

ERROR/WARNING ID: 238   1

The continuity error reported below is greater than 1 part in 1000 and is therefore considered high.

Did you specify any "special actions"? If so, they could account for it.

Relevant data are:
DATE/TIME: 1992/ 8/31 24: 0

RCHRES :   1

RELERR	STORS	STOR	MATIN	MATDIF
-2.427E-03	0.00000	0.0000E+00	0.00000	-1.564E-07

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

ERROR/WARNING ID: 238   1

The continuity error reported below is greater than 1 part in 1000 and is therefore considered high.

Did you specify any "special actions"? If so, they could account for it.

Relevant data are:
DATE/TIME: 2016/ 8/31 24: 0

RCHRES :   1

RELERR	STORS	STOR	MATIN	MATDIF
-2.431E-01	0.00000	0.0000E+00	0.00000	-1.176E-09

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.

REFVAL is the reference value (STORS+MATIN).
STOR is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

The count for the WARNING printed above has reached its maximum.

If the condition is encountered again the message will not be repeated.

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Olympia, WA. 98501
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202 East 34th Street
Tacoma, WA 98404

Appendix D: Support for the infeasibility of the items in the LID list approach

MIGIZI GROUP, INC.

PO Box 44840
Tacoma, Washington 98448

PHONE (253) 537-9400
FAX (253) 537-9401

August 25, 2023

Absher Construction
1001 Shaw Road
Puyallup, WA 98372

Attention: Greg Helle
Executive VP, Operations

Subject: **Project Infiltration Feasibility Letter**
Proposed East Town Crossing Development
13102 East Pioneer Rd.
Puyallup, WA 98372
Parcel No. 0420264053, 0420264054, 0420351066

MGI Project Z0582

Dear Mr. Helle:

Migizi Group, Inc. (MGI) is pleased to submit this letter discussing the long-term feasibility of infiltration facilities and permeable pavement at the proposed East Town Crossing development along East Pioneer Road in Puyallup, WA. Previous geotechnical studies for this site were performed by Krazan & Associates and are attached. This includes a *Geotechnical Engineering Investigation* report, dated April 11, 2019, and a March 19, 2021, *Addendum Letter*.

The purpose of this letter is to summarize our geologic research for the project area and immediate region, our review of the previous site reconnaissance, geologic explorations, and infiltration testing performed by Krazan & Associates, and provide MGI's professional recommendations for infiltration feasibility at the site.

SITE AND PROJECT DESCRIPTION

The project site consists of three contiguous parcels, creating a roughly rectangular project area 10.00 acres in size, located along the south side of East Pioneer Road, just east of downtown Puyallup, WA, as shown on the enclosed Topographic and Location Map (Figure 1). The entire parcel is currently undeveloped. The vegetated property is bordered to the north by E Pioneer Rd., to the east by undeveloped land, to the west by Shaw Road, and to the south by a commercial property that houses Absher Construction Office.

The proposed improvements generally consist of eight three-story, wood framed, multi-family apartment buildings, with associated parking stalls, covered car ports, recreational and landscaping areas. A club house will also be constructed at the north end of the site. A total of 70 one-bedroom and 108 two-bedroom units will be created. Three underground storage stormwater facilities, called R-Tank modules, are planned for the detention of generated stormwater. A modular wetland will provide treatment.

In addition to the R-Tank modules, stormwater management procedures will also involve the implementation of Low Impact Development (LID) best management practices (BMPs) to facilitate treatment and infiltration of onsite generated stormwater. This could also include implementation of shallow-depth LID BMPs such as pervious pavement roadways and rain gardens, which are common in developments where deeper infiltration has been proven infeasible due to shallow groundwater tables and/or hydraulically restrictive soils.

LOCAL GEOLOGY

The project area is located along the southern edge of the Puyallup River Valley and at the toe of the Puyallup Highlands slope, roughly between Sumner and Puyallup. The *Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington (2015)*, identifies the project area as Qa – Holocene Alluvium. Deposits tend to vary from massive deposits of loose fluvial silts, sands, and gravels, and can locally include sandy to silty estuarine deposits. Puyallup River deposits typically contain local deposits of peat or larger woody debris at depth. An excerpt of the geologic map of the immediate project area (Figure 2) can be found below:

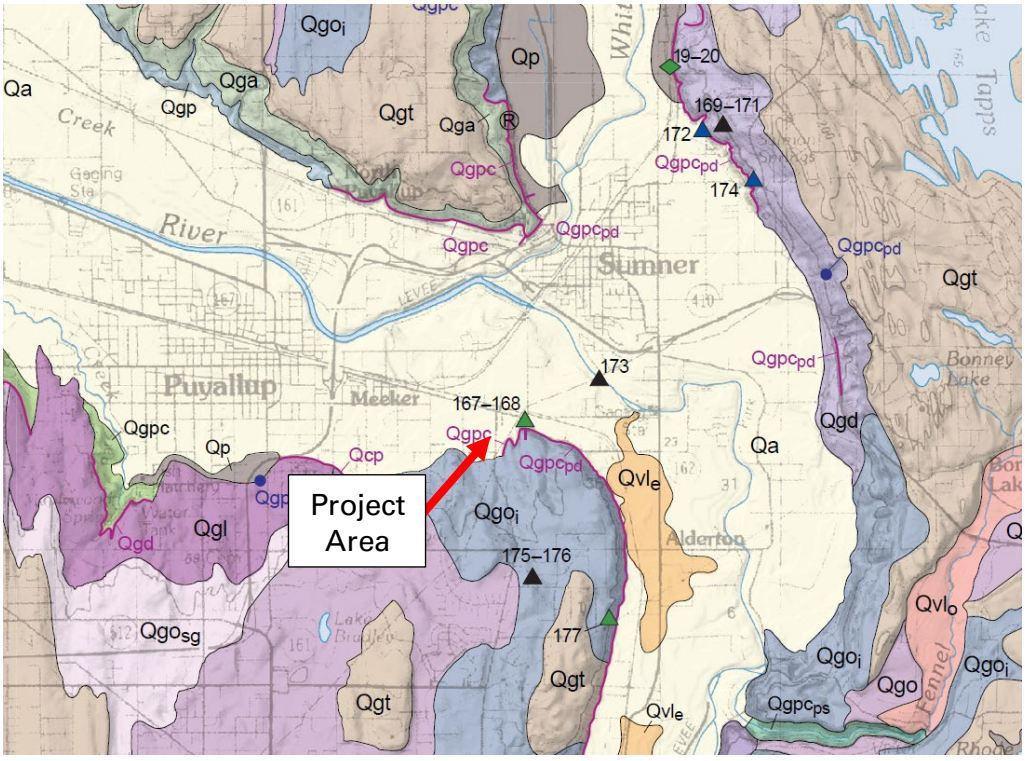


Figure 2: Immediate project area; excerpt of Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington, WSDNR, Schuster et al. 2015.

PREVIOUS PROJECT RECONNAISSANCE AND EXPLORATIONS

Previous explorations by Krazan & Associates included three hollow stem auger borings drilled across the site. In addition, two groundwater monitoring wells also installed at the same time. Drilling was conducted on March 11, 2019, which is within the wet season defined by Department of Ecology guidelines.

According to Krazan, shallow soils encountered in the borings are typical of alluvium deposits, ranging from poorly graded sand and silty sand to silty clay with interbedded seams of peat. Soils were generally observed to be moist to wet, and soft to medium dense or stiff. During drilling operations, groundwater was encountered at depths of between 7 to 8 feet below grade.

PREVIOUS INFILTRATION TESTING

On March 4-5, 2021, Krazan conducted follow up infiltration testing of the project area adjacent to monitoring wells W-1 and W-2, as described in the attached *Addendum Letter*. Krazan elected to conduct two Large-Scale Pilot Infiltration Tests (PITs), labeled P-1 and P-2, with procedures outlined in the 2014 Stormwater Management Manual for Western Washington (SWMMWW). The excavations passed through shallow undocumented fill and into the native silty sand at approximately 2 feet below grade.

The Krazan *Addendum* indicates that field testing used the procedures listed in the 2014 SWMMWW. The two excavations were filled with water and allowed to presoak for the requisite timeframe. Water level measurements taken after presoak indicated that no head change was observed within P-2 and a head increase of 0.75 inches was measured in P-1. Due to a lack of infiltration during the testing period, tests were left open overnight, and measurements were taken the following morning. Measurements taken show that water levels had again risen, with 1.2 inches of head increase in P-1, and 0.3-inch head increase in P-2.

Based on these results, Krazan and Associates concluded that shallow soils of the upper three feet of the project area represented a hydraulic restrictive layer, with the calculated infiltration rate of **0 inches per hour**, based on Site Suitability Criteria of Vol. III, Section 3.3.7 of the 2014 SWMMWW.

PERMEABLE PAVEMENT FEASIBILITY

Currently, the City of Puyallup's stormwater management has adopted the 2019 Washington State Department of Ecology's *Stormwater Management Manual for Western Washington* (SWMMWW). Volume V covers runoff treatment, flow control, and the low impact development (LID) best management practices (BMP) library. Beginning on Page 748 through 751, V-5.6 considers the BMP Permeable Pavements, the Applications and Limitations, and the Infeasibility Criteria. The manual states on page 748:

> The following infeasibility criteria describe conditions that make permeable pavement infeasible when applying The List Approach within I-3.4.5 MR5: On-Site Stormwater Management. If a project proponent wishes to use a permeable pavement BMP even though one of the infeasibility criteria within this section are met, they may propose a functional design to the local government.
>
> These criteria also apply to impervious pavements that would employ stormwater collection from the surface of impervious pavement with redistribution below the pavement.
>
> Any of the following circumstances allow the designer to determine permeable pavement as "infeasible" when applying the The List Approach within I-3.4.5 MR5: On-Site Stormwater Management:

Specifically, three bullet points listed on page 750 of the manual note that:

- Where seasonal high ground water or an underlying impermeable/low permeable layer would create saturated conditions within one foot of the bottom of the permeable pavement BMP. The bottom of the permable pavement BMP is the bottom of the lowest layer that has been designed to be part of the BMP, such as the lowest gravel base course or a sand layer used for treatment below the permeable pavement.
- Where underlying soils are unsuitable for supporting traffic loads when saturated. Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.
- Where appropriate field testing indicates soils have a measured (a.k.a., initial) native soil saturated hydraulic conductivity (K_{sat}) less than 0.3 inches per hour. See V-5.4 Determining the Design Infiltration Rate of the Native Soils. (Note: In these instances, unless other infeasibility restrictions apply, roads and parking lots may be built with an underdrain, preferably elevated within the base course, if Flow Control benefits are desired.)

Volume III Chapter 3 section 2, beginning on page 468 of the 2019 Dept. of Ecology *Stormwater Management Manual*, considers the steps of preparing a stormwater site plan. Step 1 – "Analyze Existing Site Conditions to Determine LID Feasibility" states that a **hydraulic restrictive layer** is "ground water, soil layer with less than 0.3 in/hr Ksat, bedrock, etc." Field testing conducted by Krazan during the western Washington wet season, as described above, confirms that shallow onsite soils in the upper 3 feet are classified as a hydraulicly restrictive layer and are therefore unsuitable for infiltration of site produced stormwater. These shallow soils would be the exposed subgrade base for any proposed pervious pavement subgrade reservoir in areas of pavement for the East Town Crossing development.

CONCLUSIONS

Based on the infiltration testing information provided in the *Geotechnical Engineering Investigation* (April 11, 2019), and the *Addendum Letter* (March 19, 2021) written by Krazan & Associates, and the Criteria guidelines cited in Volumes III and V of the 2019 SWMMWW, it is our opinion that shallow infiltration through the use of permeable pavement is infeasible in the onsite native soils across the project area. Without significant improvement to the in-situ subgrade soils, which could seriously comprise the infiltration characteristics, soil-supported permeable asphalt would likely fail under long term dynamic load usage, such as HS20 loading conditions.

Based on the above, it is our opinion that any generated onsite stormwater should be directed to underground R-Tank modules for detention.

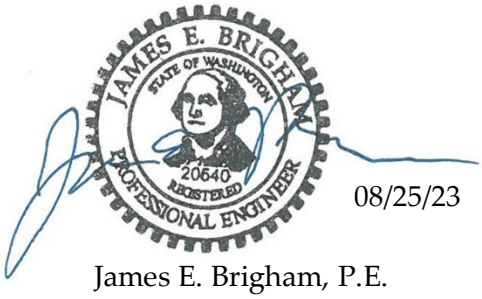
CLOSURE

We appreciate the opportunity to be of service on this project. If you have any questions regarding this letter or any aspects of the project, please feel free to contact our office.

Sincerely,

MIGIZI GROUP, INC.

Randall V. Conger-Best, L.G.
Senior Staff Geologist



08/25/23

James E. Brigham, P.E.
Senior Principal Engineer

Attachments: *Krazan and Associates, Geotechnical Engineering Investigation,* April 11, 2019
Krazan and Associates, Addendum Letter, March 19, 2021

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

April 11, 2019

KA Project No. 062-19005

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Mr. Gil Hulsmann

Email: Gil.Hulsmann@AbbeyRoadGroup.com
Tel: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation**
East Town Crossing
Parcel Nos. 0420264053, 0420264054, 0420351066
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington 98371

Dear Mr. Hulsmann,

In accordance with your request, we have completed a Geotechnical Engineering Investigation for the referenced site. The results of our investigation are presented in the attached report.

If you have any questions, or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Theresa R. Nunan

Theresa R. Nunan
Project Engineer

TRN:MR

GEOTECHNICAL ENGINEERING INVESTIGATION
EAST TOWN CROSSING
PARCEL NOS. 0420264053, 0420264054, 0420351066
SE CORNER OF E. SHAW ROAD & E. PIONEER WAY
PUYALLUP, WASHINGTON

PROJECT NO. 062-19005
APRIL 11, 2019

Prepared for:

ABBEY ROAD GROUP LAND DEVELOPMENT
SERVICES COMPANY, LLC
ATTN: MR. GIL HULSMANN
PO BOX 1224
PUYALLUP, WA 98371

Prepared by:

KRAZAN & ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING DIVISION
825 CENTER STREET, STE A
TACOMA, WASHINGTON 98409
(253) 939-2500

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April 11, 2019 KA Project No. 062-19005

GEOTECHNICAL ENGINEERING INVESTIGATION
EAST TOWN CROSSING
PARCEL NOS. 0420264053, 0420264054, 0420351066
SE CORNER OF EAST SHAW ROAD AND EAST PIONEER WAY
PUYALLUP, WASHINGTON

INTRODUCTION

This report presents the results of our Geotechnical Engineering Investigation for the proposed East Town Crossing project located near the southeast corner of East Shaw Road and East Pioneer Way in Puyallup, Washington, as shown on the Vicinity Map in Figure 1. Discussions regarding site conditions are presented in this report, together with conclusions and recommendations pertaining to site preparation, excavations, structural fill, utility trench backfill, drainage and landscaping, erosion control, foundations, concrete floor slabs and exterior flatwork, lateral earth pressures, and pavement.

A Site Plan showing the approximate exploratory boring and monitoring well locations is presented following the text of this report in Figure 2. Appendix A includes USCS Soil Classification information, as well as a description of the field investigation, exploratory boring logs, and the laboratory testing results. Appendix B contains a guide to aid in the development of earthwork specifications. Pavement design guidelines are presented in Appendix C. The recommendations in the main text of the report have precedence over the more general specifications in the appendices.

PURPOSE AND SCOPE

This investigation was conducted to evaluate the subsurface soil and groundwater conditions at the site, to develop geotechnical engineering recommendations for use in design of specific construction elements, and to provide criteria for site preparation and earthwork construction.

Our scope of services was performed in general accordance with our proposal for this project, dated January 25, 2019 (Proposal Number G19001WAT) and included the following:

- Exploration of the subsurface soil and groundwater conditions by conducting approximately three (3) geotechnical borings and installing two (2) groundwater level monitoring wells using a subcontracted drill rig;
- Provide a site plan showing the geotechnical boring and monitoring well locations;

- Provide comprehensive boring and monitoring well logs, including soil stratification and classification, and groundwater levels where applicable;
- Recommended foundation type for the proposed structures;
- Allowable foundation bearing pressure, anticipated settlements (both total and differential), coefficient of horizontal friction for footing design, and frost penetration depth;
- Recommendations for seismic design considerations including site coefficient and ground acceleration based on the 2015 IBC;
- Recommendations for structural fill materials, placement, and compaction;
- Recommendations for suitability of on-site soils as structural fill;
- Recommendations for temporary excavations;
- Recommendations for site drainage and erosion control;
- Recommendations for flexible and rigid pavements, as well as permeable pavement.

PROPOSED CONSTRUCTION

Based on the Overall Site Plan prepared by Abbey Road Group Land Development Services, dated December 12, 2018, we understand that the proposed development will include construction of six residential structures (designated Buildings A through E) and a club house/office building. Site drainage systems will include a subsurface stormwater system located in the southern portion of the property, and a rain garden along the northern and eastern edges of the site. We have not been provided with details regarding construction of the subsurface stormwater system. The planned development will also include utility installation, and paved parking areas and driveways. For the purpose of our analyses, we have assumed that the residential buildings and club house will be 1- to 2-story structures with a slab-on-grade floor system. We have also assumed only minor grading up to 1 foot of cut or fill will be required to establish planned elevations for the site.

SITE LOCATION AND DESCRIPTION

The site consists of three undeveloped parcels encompassing approximately 7 acres of land located south and east of the intersection of Shaw Road with East Pioneer Way. The site is bordered to the north by East Pioneer Way, to the south by commercial property, to the east by undeveloped land and a creek, and to the west by undeveloped land and abandoned residences. The site is roughly rectangular in shape and relatively level at approximately Elevation 72 to 74 feet. A dirt road runs north-south through the center of the site, and also extends from the center of the site westward towards Shaw Road. An existing storm pond is located in the southeast corner of the site, with the bottom at Elevation 69

feet. A wetland that has been field verified by others is located within the western central edge of the site. A creek runs along the eastern boundary of the site.

Most of the property is covered with seasonal vegetation, brambles, and a few trees located within the central portion of the site. Some trash and an abandoned trailer are located in the north central portion of the site. The southern portion of the site is currently being used by the adjacent business for container storage.

We understand that past construction activities for the undeveloped parcel to the west of the site that borders Shaw Road and East Pioneer Way consisted of the placement of fill material to raise the existing grades, based on the Geotechnical Evaluation and Additional Recommendations report prepared by Krazan & Associates, dated March 13, 2007. Those fill activities did not extend into this site.

GEOLOGIC SETTING

The site lies within the central Puget Lowland. The lowland is part of a regional north-south trending trough that extends from southwestern British Columbia to near Eugene, Oregon. North of Olympia, Washington, this lowland is glacially carved, with a depositional and erosional history including at least four separate glacial advances and retreats. The Puget Lowland is bounded to the west by the Olympic Mountains and to the east by the Cascade Range. The lowland is filled with glacial and nonglacial sediments.

The Washington Division of Geology and Earth Resources, Geologic Map of the South Half of the Tacoma Quadrangle, Washington (Open File Report 87-3) indicates that the property is located in an area that is predominantly underlain by recent alluvium deposited by the Puyallup River. The recent alluvium consists of interbedded silt, sandy silt, silty sand, sand, gravel, local areas of peat and clay. The finer material represents overbank material and local lacustrine deposits, and the coarser materials most likely represent deposits in abandoned channels of the Puyallup River.

FIELD INVESTIGATION

A field investigation consisting of three (3) exploratory soil borings and installation of two (2) monitoring wells was completed to evaluate the subsurface soil and groundwater conditions at the project location. The soil borings were completed on March 11, 2019 by a Krazan subcontractor utilizing a hollow stem auger drill rig. The soil borings were advanced to depths ranging from 21.5 to 38.5 feet below the existing ground surface (bgs). A geotechnical engineer from Krazan and Associates was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations.

Representative samples of the subsurface soils encountered in the borings were collected and sealed in plastic bags. These samples were transported to our laboratory for further examination and testing. The

soils encountered in the exploratory borings were continuously examined and visually classified in accordance with the Unified Soil Classification System (USCS).

SOIL PROFILE AND SUBSURFACE CONDITIONS

The geotechnical subsurface exploration for this project consisted of soil borings and monitoring wells advanced to depths of approximately 21.5 to 38.5 feet bgs. The locations of the soil borings and monitoring wells are shown on the Site Plan in Figure 2.

Beneath 5 to 8 inches of surficial topsoil, the borings encountered alluvial soils to their explored depths. The topsoil was underlain by 4.5 to 7 feet of brown silty sand (SM) and poorly graded sand (SP) with relative densities in the loose to medium dense range. The sand soils were underlain by a 3-foot thick stratum of interbedded sandy silt (ML) that exhibited medium stiff to stiff consistencies and silty sand (SM) soils with relative densities in the loose to medium dense range.

Boring B-1 encountered a layer of silty clay and clayey silt beneath the sandy silt and silty sands from 7.5 to 11.0 feet bgs. The silty clay (CL) and clayey silt (ML) exhibited a very soft consistency with a Standard Penetration Test (SPT) resistance (N-value) of 1/12 inches and a moisture content of 51 percent.

The clayey silt in boring B-1 and the silty sand/sandy silt stratum in borings B-2 and B-3 were underlain by silty sand, sand, and gravel soils with varying silt contents to the termination depths of 21.5, 38.5, and 21.5 feet bgs, respectively. These granular soils exhibited relative densities in the loose to very dense range with N-values ranging from 8 to 60/8" blows per foot.

Gradation and Atterberg Limits tests were conducted on representative samples of the soils for classification purposes and for determination of engineering properties. The gradation and Atterberg Limits results are graphically depicted in Appendix A. For additional information about the soils encountered, please refer to the boring logs in Appendix A.

Monitoring Wells: Two monitoring wells, designated W-1 and W-2, were installed at the site on March 11, 2019 using a subcontracted driller and track mounted drill rig. Monitoring well W-1 was installed within borehole B-1. The boreholes for monitoring wells W-1 and W-2 were advanced to a depth of 21.5 feet and 20 feet below the existing ground surface, respectively, using 4¼-inch diameter hollow stem augers. A 10-foot long section of slotted PVC pipe attached to a 10-foot section of solid PVC pipe was inserted into the borehole, and the annular space between the pipe and the augers was backfilled with filter sand to a depth of 8 feet bgs followed by bentonite chips to the ground surface. A metal well cap was then installed over the pipe and cemented in-place to protect the well from unauthorized access. The installation log for monitoring wells W-1 and W-2 are included in Appendix A.

GROUNDWATER

Groundwater was encountered during the drilling operations at a depth of about 7 to 8 feet below the existing ground surface. It should be recognized that groundwater elevations may fluctuate with time. The groundwater level will be dependent upon seasonal precipitation, irrigation, land use, climatic conditions, as well as other factors. Therefore, water levels at the time of the field investigation may be different from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

GEOLOGIC HAZARDS

Erosion Concern/Hazard

The Natural Resources Conservation Services (NRCS) map for Pierce County Area, Washington, classifies the site area as Briscot loam. The NRCS classifies the Briscot loam as Hydrologic Soil Group B/D with low potential for erosion in a disturbed state.

It has been our experience that soil erosion can be minimized through landscaping and surface water runoff control. Typically, erosion of exposed soils will be most noticeable during periods of rainfall and may be controlled by the use of normal temporary erosion control measures, i.e., silt fences, hay bales, mulching, control ditches or diversion trenching, and contour furrowing. Erosion control measures should be in place before the onset of wet weather.

Seismic Hazard

The 2015 International Building Code (IBC), Section 1613.3.2, refers to Chapter 20 of ASCE-7 for Site Class Definitions. It is our opinion that the overall soil profile corresponds to Site Class D as defined by Table 20.3-1 "Site Class Definitions," according to the 2010 ASCE-7 Standard. Site Class D applies to a "stiff soil" profile. The seismic site class is based on a soil profile extending to a depth of 100 feet. The soil borings on this site extended to a maximum depth of 38.5 feet and this seismic site class designation is based on the assumption that similar soil conditions continue below the depth explored.

We referred to the U.S. Geological Survey (USGS) Earthquake Hazards Program Website and 2012/2015 IBC to obtain values for S_S, S_{MS}, S_{DS}, S_1, S_{M1}, S_{D1}, F_a, and F_v. The USGS website includes the most updated published data on seismic conditions. The seismic design parameters for this site are as follows:

Seismic Design Parameters
(Reference: 2015 IBC Section 1613.3.2, ASCE, and USGS)

Seismic Item	Value
Site Coefficient F_a	1.003
S_s	1.243 g
S_{MS}	1.247 g
S_{DS}	0.831 g
Site Coefficient F_v	1.524
S_1	0.476 g
S_{M1}	0.726 g
S_{D1}	0.484 g

Additional seismic considerations include liquefaction potential and amplification of ground motions by loose/soft soil deposits. The liquefaction potential is highest for loose sand with a high groundwater table. Soil liquefaction is a state where soil particles lose contact with each other and become suspended in a viscous fluid. This suspension of the soil grains results in a complete loss of strength as the effective stress drops to zero. Liquefaction normally occurs under saturated conditions in soils such as sand in which the strength is purely frictional. However, liquefaction has occurred in soils other than clean sand. Liquefaction usually occurs under vibratory conditions such as those induced by seismic events.

We have reviewed "Liquefaction Susceptibility Map of Pierce County, Washington" by Stephen P. Palmer et al., (WA DNR, 2004). The map indicates that the site area is located in a zone of high liquefaction susceptibility. At the request of our client, we have conducted a site-specific liquefaction analysis for this project.

To evaluate the liquefaction potential of the site, we analyzed the following factors:

1) Soil type
2) Groundwater depth
3) Relative soil density
4) Initial confining pressure
5) Maximum anticipated intensity and duration of ground shaking

Liquefaction Analysis: The commercially available liquefaction analysis software, LiquefyPro from CivilTech, was used to evaluate the liquefaction potential and the possible liquefaction induced settlement for the site soil and groundwater conditions based on our explorations. The analysis was performed using the information from the soil test boring and laboratory gradation analyses. Maximum

Considered Earthquake (MCE) was selected in accordance with the 2015 International Building Code (IBC) Chapter 16 and the U.S. Geological Survey (USGS) Earthquake Hazards Program website. For this analysis, a maximum earthquake magnitude of 7.11 and peak horizontal ground surface acceleration of 0.5g were used. Our analysis assumed a groundwater depth of 7.0 feet during the earthquake.

The maximum liquefaction induced settlement for this type of seismic event is estimated to be on the order of about 2 inches. The differential settlements are estimated to be on the order of about 1-inch.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned improvements at this site are feasible, provided that the geotechnical engineering recommendations presented in this report are included in the project design. Based on our explorations, it is our opinion that conventional spread foundations supported on medium dense/stiff or firmer native soil, or on structural fill extending to the medium dense/stiff or firmer native soil would be appropriate for the new buildings.

We recommend that organic topsoil, undocumented fill, and loose/soft soils be stripped to expose the underlying medium dense/stiff or firmer native soil. Footings should extend through any organic or loose soil and be founded on the underlying medium dense or firmer native soil, or structural fill extending to the competent native soils.

Exploration boring B-1 was drilled in the northern portion of the site, in the area of the planned rain garden between Pioneer Way and the Club House and Residential Building E. Boring B-1 encountered a layer of very soft silty clay between 7.5 and 11 feet below the existing ground surface. These materials are not considered suitable to support foundations and will need to be removed where they are encountered. Test pits should be conducted prior to the construction phase to determine the aerial extent (i.e. lateral extent and depth) of this very soft clay layer. If the additional test pit exploration reveals that the soft clay layer extends into the footprint of the Clubhouse or Residential Building E, or any of the other structures, additional foundation recommendations will be necessary to address the effect of the very soft clays. If the very soft clay is encountered in building areas, a deep foundation system may be required for support of the structure(s).

Borings B-2 and B-3 (drilled within the eastern and southern portions of the site) and monitoring well W-2 (installed within the central portion of the site) encountered medium dense/stiff native soils at depths of approximately 5 and 7 feet bgs, respectively; however, deeper layers of loose/soft soils may be encountered in unexplored areas of the site.

The soils encountered on this site are considered moisture-sensitive and will be easily disturbed and difficult to compact when wet. We recommend that construction take place during the drier summer months, if possible. If construction is to take place during wet weather, additional expenses and delays

should be expected due to the wet conditions. Additional expenses could include the need for placing a blanket of rock spalls to protect exposed subgrades and construction traffic areas.

Site Preparation

General site clearing should include removal of any undocumented fill, organics, asphaltic concrete, abandoned utilities, structures including foundations, basement walls and floors, rubble, and rubbish. After stripping operations and removal of any loose and/or debris-laden fill, the exposed subgrade should be visually inspected and/or proof rolled to identify any soft/loose areas. Additional recommendations for preparation of specific areas are provided in the **Foundations**, **Pavement Design** and **Exterior Flatwork** subsections of this report.

The soils that will be encountered during site development are considered extremely moisture-sensitive and may disturb easily in wet conditions. The prepared subgrade should be protected from construction traffic and surface water should be diverted around prepared subgrade. We recommend that the site be developed only during extended periods of dry weather.

During wet weather conditions, subgrade stability problems and grading difficulties may develop due to excess moisture, disturbance of sensitive soils and/or the presence of perched groundwater. Construction during the extended periods of wet weather could result in the need to remove wet disturbed soils if they cannot be suitably compacted due to elevated moisture contents. The onsite soils have significant silt content in the explored areas and are moisture sensitive, and can be easily disturbed when wet. If over-excavation is necessary, it should be confirmed through continuous monitoring and testing by a qualified geotechnical engineer or geologist. Soils that have become unstable may require drying to near their optimal moisture content before compaction is feasible. Selective drying may be accomplished by scarifying or windrowing surficial material during extended periods of dry, warm weather (typically during the summer months). If the soils cannot be dried back to a workable moisture condition, remedial measures may be required. General project site winterization should consist of the placement of aggregate base and the protection of exposed soils during the construction phase. It should be understood that even if Best Management Practices (BMP's) for wintertime soil protection are implemented and followed there is a significant chance that moisture disturbed soil mitigation work will still be required.

Any buried structures encountered during construction should be properly removed and backfilled. Excavations, depressions, or soft and pliant areas extending below the planned finish subgrade levels should be excavated to expose firm undisturbed soil, and backfilled with structural fill. In general, any septic tanks, underground storage tanks, debris pits, cesspools, or similar structures should be completely removed. Concrete footings should be removed to an equivalent depth of at least 3 feet below proposed footing elevations or as reecommended by the geotechnical engineer. The resulting excavations should be backfilled with structural fill.

We understand that backfilling of the wetland in the central western edge of the site that has been field identified by others will be permitted for construction of the paved parking area and subsurface storm system. We also understand that proposed Residential Building C will be constructed within the area currently occupied by an existing storm pond. Our field explorations were not specifically conducted within either of these areas. Any organic, silt or clay soils, or accumulations of sediment, encountered within the wetland area or the existing storm pond should be removed down to firm undisturbed soil, and backfilled with structural fill to the planned finish grades.

A representative of our firm should be present during all site clearing and grading operations to observe, test and evaluate earthwork construction. This testing and observation is an integral part of our service, as acceptance of earthwork construction is dependent upon compaction and stability of the material. The geotechnical engineer may reject any material that does not meet compaction and stability requirements. Further recommendations, contained in this report, are predicated upon the assumption that earthwork construction will conform to the recommendations set forth in this section and in the Structural Fill section below.

Temporary Excavations

The onsite soils have variable cohesion strengths, therefore the safe angles to which these materials may be cut for temporary excavations is limited, as the soils may be prone to caving and slope failures in temporary excavations. Temporary excavations in the loose to medium dense native soils should be sloped no steeper than 2H:1V (horizontal to vertical) where room permits.

All temporary cuts should be in accordance with Washington Administrative Code (WAC) Part N, Excavation, Trenching, and Shoring. The temporary slope cuts should be visually inspected daily by a qualified person during construction work activities and the results of the inspections should be included in daily reports. The contractor is responsible for maintaining the stability of the temporary cut slopes and minimizing slope erosion during construction. The temporary cut slopes should be covered with plastic sheeting to help minimize erosion during wet weather and the slopes should be closely monitored until the permanent retaining systems are complete. Materials should not be stored and equipment operated within 10 feet of the top of any temporary cut slope.

A Krazan & Associates geologist or geotechnical engineer should observe, at least periodically, the temporary cut slopes during the excavation work. The reasoning for this is that all soil conditions may not be fully delineated by the limited sampling of the site from the geotechnical explorations. In the case of temporary slope cuts, the existing soil conditions may not be fully revealed until the excavation work exposes the soil. Typically, as excavation work progresses the maximum inclination of the temporary slope will need to be evaluated by the geotechnical engineer so that supplemental recommendations can be made. Soil and groundwater conditions can be highly variable. Scheduling for soil work will need to be adjustable, to deal with unanticipated conditions, so that the project can proceed smoothly and required deadlines can be met. If any variations or undesirable conditions are

encountered during construction, Krazan & Associates should be notified so that supplemental recommendations can be made.

Structural Fill

Fill placed beneath foundations, pavement, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the Site Preparation subsection of this report prior to beginning fill placement.

Best Management Practices (BMP's) should be followed when considering the suitability of the existing materials for use as structural fill. The on-site soils are generally considered suitable for re-use as structural fill, provided the soil is free of organic material and debris, and it is within ± 2 percent of the optimum moisture content. If the native soils are stockpiled for later use as structural fill, the stockpiles should be covered to protect the soil from wet weather conditions. We recommend that a representative of Krazan & Associates be on site during the excavation work to determine which soils are suitable for use as structural fill.

Imported, all weather structural fill material should consist of well-graded gravel or a sand and gravel mixture with a maximum grain size of 3 inches and less than 5 percent fines (material passing the U.S. Standard No. 200 Sieve). All structural fill material should be submitted for approval to the geotechnical engineer at least 48 hours prior to delivery to the site.

Fill soils should be placed in horizontal lifts not exceeding 8 inches in thickness prior to compaction, moisture-conditioned as necessary (moisture content of soil shall not vary by more than ±2 percent of optimum moisture), and the material should be compacted to at least 95 percent of the maximum dry density based on ASTM D1557 Test Method. In-place density tests should be performed on all structural fill to document proper moisture content and adequate compaction. Additional lifts should not be placed if the previous lift did not meet the compaction requirements or if soil conditions are not considered stable.

Foundations

Our exploratory borings encountered loose to medium dense granular soils underlain by a 3-foot thick stratum of interbedded sandy silt and silty sand, followed by loose to very dense granular alluvial soils to the explored depths. Boring B-1, drilled at the proposed rain garden area in the northern end of the site, encountered a 3.5-foot thick layer of very soft silty clay at a depth of 7.5 feet bgs.

The very soft clay encountered in Boring B-1 between 7.5 and 11 feet below the existing ground surface is not considered suitable to support foundations and will need to be removed where it is encountered.

Further exploration of this area with test pits should be conducted during the planning phase to determine the aerial extent (i.e. lateral extent and depth) of this very soft clay layer. If the additional test pit exploration reveals that the soft clay layer extends into the footprint of the Clubhouse or Residential Building E, or any of the other structures, additional foundation recommendations will be necessary to address the effect of the very soft clays. If the very soft clay is encountered in building areas, a deep foundation system may be required for support of the structure(s).

Borings B-2 and B-3 and monitoring well W-2, drilled within the eastern, southern, and central portions of the site, encountered medium dense/stiff native soils at depths of approximately 5 and 7 feet bgs; however, deeper layers of loose/soft soils may be encountered in unexplored areas of the site.

Pending the findings of further explorations in the northern portion of the site, the proposed structures may be supported on a shallow foundation system. Where loose/soft soils are encountered at the planned footing elevations, the subgrade should be over-excavated to expose suitable bearing soil. The foundation excavations should be evaluated by Krazan & Associates prior to structural fill placement to verify that the foundations will bear on suitable material.

Building foundations should extend at least 18 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Footing widths should be based on the anticipated loads and allowable soil bearing pressure, and should conform to current International Building Code (IBC) guidelines. Water should not be allowed to accumulate in foundation excavations. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable design bearing capacity of 2,000 pounds per square foot (psf) may be used for foundation design for this project. A representative of Krazan and Associates should evaluate the foundation bearing soil prior to footing form construction.

Resistance to lateral footing displacement can be computed using an allowable friction factor of 0.35 acting between the bases of foundations and the supporting subgrade. Lateral resistance for footings can alternatively be developed using an allowable equivalent fluid passive pressure of 150 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces (neglecting the upper 12 inches). The allowable friction factor and allowable equivalent fluid passive pressure values include a factor of safety of 1.5. The frictional and passive resistance of the soil may be combined without reduction in determining the total lateral resistance. A 1/3 increase in the above values may be used for short duration wind and seismic loads.

For foundations constructed as recommended, the total static settlement is not expected to exceed 1-inch. Differential settlement, along a 20-foot exterior wall footing, or between adjoining column footings should be less than ½ inch. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils become flooded or saturated. It should be noted that the estimated settlement provided herewith is a

static settlement and does not include liquefaction induced settlement. Static settlement is induced by the applied dead load from the structures.

Up to 2 inches of total settlement and 1 inch of differential settlement could occur during and/or following a seismic event. The foundation elements, i.e. spread and wall footings, could be structurally tied together to create a stiffer structure. It should be noted that this measure would not mitigate the anticipated seismic settlement; however, it may reduce the damage associated with the anticipated seismic settlement, particularly the effects of differential settlement on a structure.

Seasonal rainfall, water run-off, and the normal practice of watering trees and landscaping areas around the proposed structures, should not be permitted to flood and/or saturate foundation subgrade soils. To prevent the buildup of water within the footing areas, continuous footing drains (with cleanouts) should be provided at the bases of the footings. The footing drains should consist of a minimum 4-inch diameter rigid perforated PVC pipe, sloped to drain, with perforations placed near the bottom and enveloped in all directions by washed rock and wrapped with filter fabric to limit the migration of silt and clay into the drain.

Lateral Earth Pressures and Retaining Walls

We understand that a below grade stormwater vault is planned for this project. We have developed criteria for the design of retaining or below grade walls for the stormwater vault. Our design parameters are based on retention of the native soils. The parameters are also based on level, well-drained wall backfill conditions. Walls may be designed as "restrained" retaining walls based on "at-rest" earth pressures, plus any surcharge on top of the walls as described below, if the walls are braced to restrain movement and/or movement is not acceptable. Unrestrained walls may be designed based on "active" earth pressure, if the walls are not part of the buildings and some movement of the retaining walls is acceptable. Acceptable lateral movement equal to at least 0.2 percent of the wall height would warrant the use of "active" earth pressure values for design. We recommend that walls supporting horizontal backfill and not subjected to hydrostatic forces be designed using a triangular earth pressure distribution equivalent to that exerted by a fluid with a density of 38 pcf for yielding (active condition) walls, and 60 pcf for non-yielding (at-rest condition) walls.

The stated lateral earth pressures do not include the effects of hydrostatic pressure generated by water accumulation behind the retaining walls or loads imposed by construction equipment, foundations, back slopes or roadways (surcharge loads). Groundwater was encountered in each of the borings at 7 to 8 feet below the ground surface. Portions of the vault that will extend below the groundwater level will need to be designed to resist hydrostatic pressures and buoyant forces. Equivalent fluid densities for buoyant soil pressure under yielding conditions would be 20 pcf and 30 pcf for nonyielding conditions. The allowable buoyant passive pressure would be 100 pcf with a factor of safety of 2.0.

Floor Slabs and Exterior Flatwork

Before the placement of concrete floors or pavements on the site, or before any floor supporting fill is placed, the loose soils and undocumented fill must be removed to expose medium dense or firmer undisturbed native soil. The subgrade should then be proof-rolled to confirm that the subgrade contains no soft or deflecting areas. Areas of yielding soils should be excavated and backfilled with structural fill.

Any additional fill used to increase the elevation of the floor slab should meet the requirements of structural fill. Fill soils should be placed in horizontal lifts not exceeding 8 inches loose thickness, moisture-conditioned as necessary, (moisture content of soil shall not vary by more than ±2 percent of optimum moisture) and the material should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557.

Floor slabs may be designed using a modulus of subgrade reaction value of k = 200 pounds per cubic inch (pci) for slabs supported on medium dense or firmer native soils or on structural fill extending to medium dense or firmer native soil.

In areas where it is desired to reduce floor dampness, such as areas covered with moisture sensitive floor coverings, we recommend that concrete slab-on-grade floors be underlain by a water vapor retarder system. According to ASTM guidelines, the water vapor retarder should consist of a vapor retarder sheeting underlain by a minimum of 4-inches of compacted clean (less than 5 percent passing the U.S. Standard No. 200 Sieve), open-graded angular rock of ¾-inch maximum size. The vapor retarder sheeting should be protected from puncture damage.

It is recommended that the utility trenches within the building pads be compacted, as specified in our report, to minimize the transmission of moisture through the utility trench backfill. Special attention to the drainage and irrigation adjacent to the buildings is recommended. Grading should establish drainage away from the structures and this drainage pattern should be maintained. Water should not be allowed to collect adjacent to the structures. Excessive irrigation within landscaped areas adjacent to the structure should not be allowed to occur. In addition, ventilation of the structure may be prudent to reduce the accumulation of interior moisture.

Erosion and Sediment Control

Erosion and sediment control (ESC) is used to minimize the transportation of sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be implemented and these measures should be in general accordance with local regulations. As a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features of the site:

1) Phase the soil, foundation, utility and other work, requiring excavation or the disturbance of the site soils, to take place during the dry season (generally May through September). However, provided precautions are taken using Best Management Practices (BMP's), grading activities can be undertaken during the wet season (generally October through April), but it should also be known that this may increase the overall cost of the project.

2) All site work should be completed and stabilized as quickly as possible.

3) Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.

4) Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited, other filtration methods will need to be incorporated.

Groundwater Influence on Structures and Earthwork Construction

The soil borings were checked for the presence of groundwater during exploratory operations. Groundwater was encountered in all of our borings at approximately 7 to 8 feet bgs. It should be recognized that groundwater elevations may fluctuate with time. The groundwater level will be dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. Therefore, groundwater levels at the time of the field investigation may be different from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

If groundwater is encountered during construction, we should observe the conditions to determine if dewatering will be needed. Design of temporary dewatering systems to remove groundwater should be the responsibility of the contractor. If earthwork is performed during or soon after periods of precipitation, the subgrade soils may become saturated. These soils may "pump," and the materials may not respond to densification techniques. Typical remedial measures include: disking and aerating the soil during dry weather; mixing the soil with drier materials; removing and replacing the soil with an approved fill material. A qualified geotechnical engineering firm should be consulted prior to implementing remedial measures to observe the unstable subgrade conditions and provide appropriate recommendations.

Drainage

The ground surface should slope away from building pads and pavement areas, toward appropriate drop inlets or other surface drainage devices. It is recommended that adjacent exterior grades be sloped a

minimum of 2 percent for a minimum distance of 5 feet away from structures. Roof drains should be tightlined away from foundations. Roof drains should not be connected to the footing drains.

Pavement areas should be inclined at a minimum of 1 percent and drainage gradients should be maintained to carry all surface water to collection facilities and suitable outlets. These grades should be maintained for the life of the project.

Specific recommendations for and design of storm water disposal systems or septic disposal systems are beyond the scope of our services and should be prepared by other consultants that are familiar with design and discharge requirements.

Utility Trench Backfill

Utility trenches should be excavated according to accepted engineering practices following OSHA (Occupational Safety and Health Administration) standards, by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be minimized; cyclic wetting and drying of excavation side slopes should be avoided.

All utility trench backfill should consist of suitable on-site material or imported granular material. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 5 feet of utility trench backfill placed in pavement areas should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 5 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with the pipe manufacturer's recommendations.

The contractor is responsible for removing all water-sensitive soils from the trenches regardless of the backfill location and compaction requirements. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction.

Pavement Design

Based on our explorations, the near surface soils at the site are interpreted as loose to medium dense silty sand and sand soils to depths of approximately 4.5 to 7.0 feet bgs. Due to the loose nature of the anticipated pavement subgrade soils, we recommend that subgrade modification techniques be considered. Subgrade modification typically includes the over-excavation of unsuitable materials, the placement of a geotextile fabric at the bottom of the over-excavated area, and then the placement of structural fill, with the structural fill consisting of clean crushed rock, rock spalls, or Controlled Density Fill (CDF). We recommend the use of a high-strength geotextile separation fabric, such as Mirafi 600X

or equivalent, for the geotextile. Subgrade modification such as this is intended to disperse surcharge loads and therefore aid in pavement performance.

Where loose soils are encountered in the pavement subgrade, we recommend over-excavation of the loose soil to at least 12 inches below the planned pavement subgrade elevation. The exposed grade after the over-excavation should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. We recommend that a high-strength geotextile separation fabric, such as Mirafi 600X or equivalent, then be placed over the compacted soil. After the fabric is placed, the area should be filled to the planned slab subgrade elevation with structural fill. The structural fill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. In-place density tests should be performed to verify proper moisture content and adequate compaction.

In areas where the pavement subgrade soil consists of firm and unyielding native soils, a proof roll of the pavement subgrade soil may be performed in lieu of the compaction and in-place density tests. It should be noted that subgrade soils that have relatively high silt contents may be highly sensitive to moisture conditions. The subgrade strength and performance characteristics of a silty subgrade material may be dramatically reduced if this material becomes wet.

Traffic loads were not provided, however, based on our knowledge of the proposed project, we expect the traffic to range from light duty (passenger automobiles) to heavy duty (delivery and fire trucks). Pavement design life of 20 years was assumed for our analysis. Recommendations for an asphaltic concrete flexible pavement section and Portland Cement Concrete (PCC) rigid pavement section are provided in Tables 1 and 2 below.

Table 1: ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT

Asphaltic Concrete	Aggregate Base	Compacted Subgrade**
3.0 in.	6.0 in.	12.0 in.

Table 2: PORTLAND CEMENT CONCRETE (RIGID) PAVEMENT
4000 psi with FIBER MESH

Min. PCC Depth	Aggregate Base	Compacted Subgrade**
6.0 in.	4.0 in.	12.0 in.

** *A proof roll may be performed in lieu of in-place density tests*

The asphaltic concrete depth listed in Table 1 for the flexible pavement section should be a surface course type asphalt, such as Washington Department of Transportation (WSDOT) ½-inch Hot Mix Asphalt (HMA). The pavement specification in Appendix C provides additional recommendations, including aggregate base material.

Testing and Inspection

A representative of Krazan & Associates, Inc. should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of our services as acceptance of earthwork construction is dependent upon compaction testing and stability of the material. This representative can also verify that the intent of these recommendations is incorporated into the project design and construction. We should also be present during the construction of stormwater management system to evaluate the soils. Krazan & Associates, Inc. will not be responsible for grades or staking, since this is the responsibility of the Prime Contractor. Furthermore, Krazan & Associates is not responsible for the contractor's procedures, methods, scheduling or management of the work site.

LIMITATIONS

Geotechnical engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences improves. Although your site was analyzed using the most appropriate current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to improvements in the field of geotechnical engineering, physical changes in the site either due to excavation or fill placement, new agency regulations or possible changes in the proposed structure after the time of completion of the soils report may require the soils report to be professionally reviewed. In light of this, the owner should be aware that there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that two years be considered a reasonable time for the usefulness of this report.

Foundation and earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original foundation investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. Our report, design conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. The findings and conclusions of this report can be affected by the passage of time, such as seasonal weather conditions, manmade influences, such as construction on or adjacent to the site, natural events such as earthquakes, slope instability, flooding, or groundwater fluctuations. If any variations or undesirable conditions are encountered during construction, the geotechnical engineer should be notified so that supplemental recommendations can be made.

The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The geotechnical engineer should be notified of any changes so that the recommendations can be reviewed and reevaluated.

Misinterpretations of this report by other design team members can result in project delays and cost overruns. These risks can be reduced by having Krazan & Associates, Inc. involved with the design teams' meetings and discussions after submitting the report. Krazan & Associates, Inc. should also be retained for reviewing pertinent elements of the design team's plans and specifications. Contractors can also misinterpret this report. To reduce this, risk Krazan & Associates. Inc. should participate in pre-bid and preconstruction meetings, and provide construction observations during the site work.

This report is a geotechnical engineering investigation with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands. Any statements or absence of statements, in this report or on any soils log regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous and/or toxic assessments.

The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments. We emphasize that this report is valid for this project as outlined above, and should not be used for any other site. Our report is prepared for the exclusive use of our client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

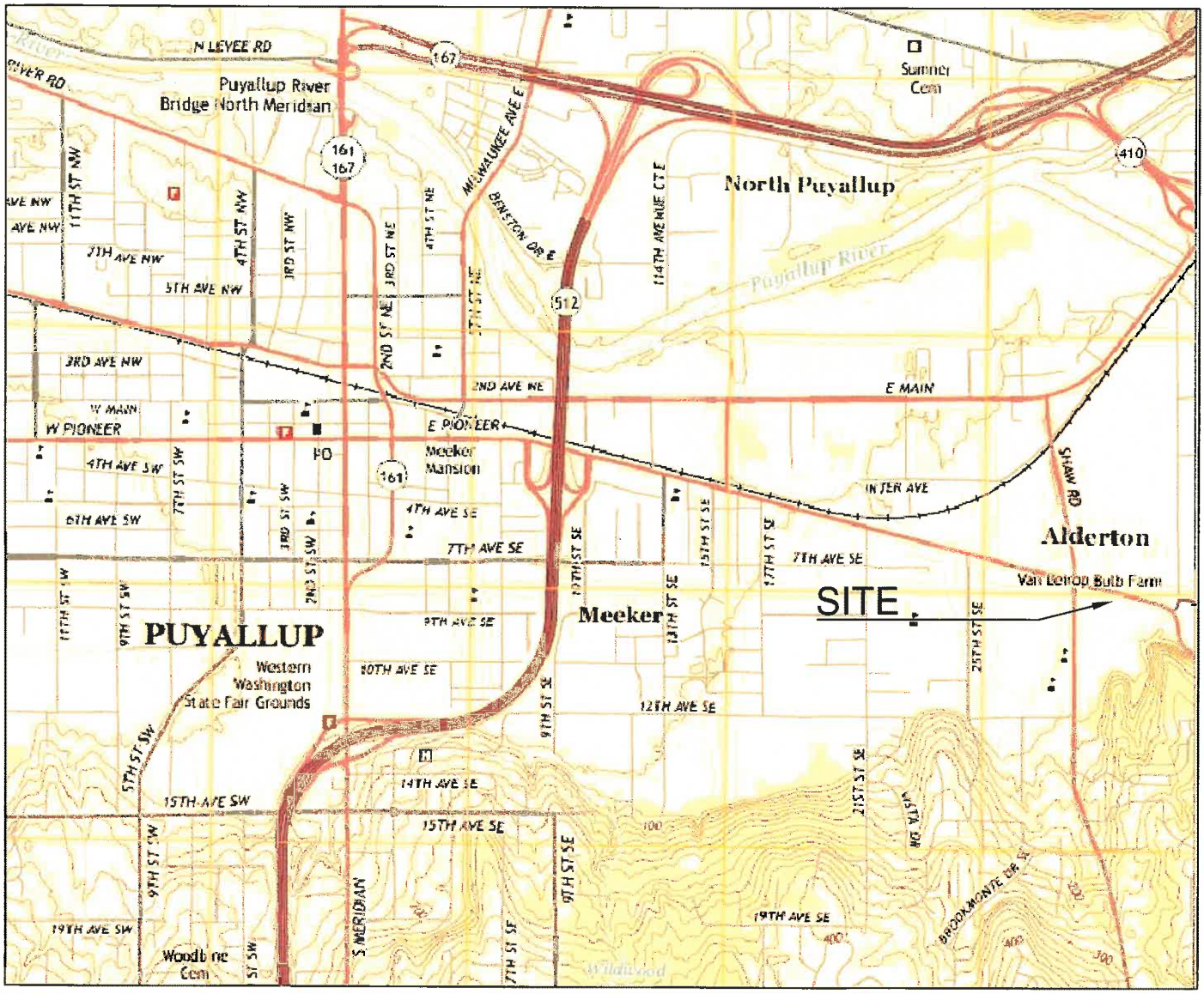
04/11/19

Theresa R. Nunan

Michael D. Rundquist, P.E.
Senior Project Manager

Theresa R. Nunan
Project Engineer

TRN:MDR



Reference: USGS topographic map website, Puyallup, WA, dated 2017.

N

Vicinity Map

East Town Crossing

Shaw Rd & E Pioneer Way, Puyallup, WA

Project Number: 062-19007

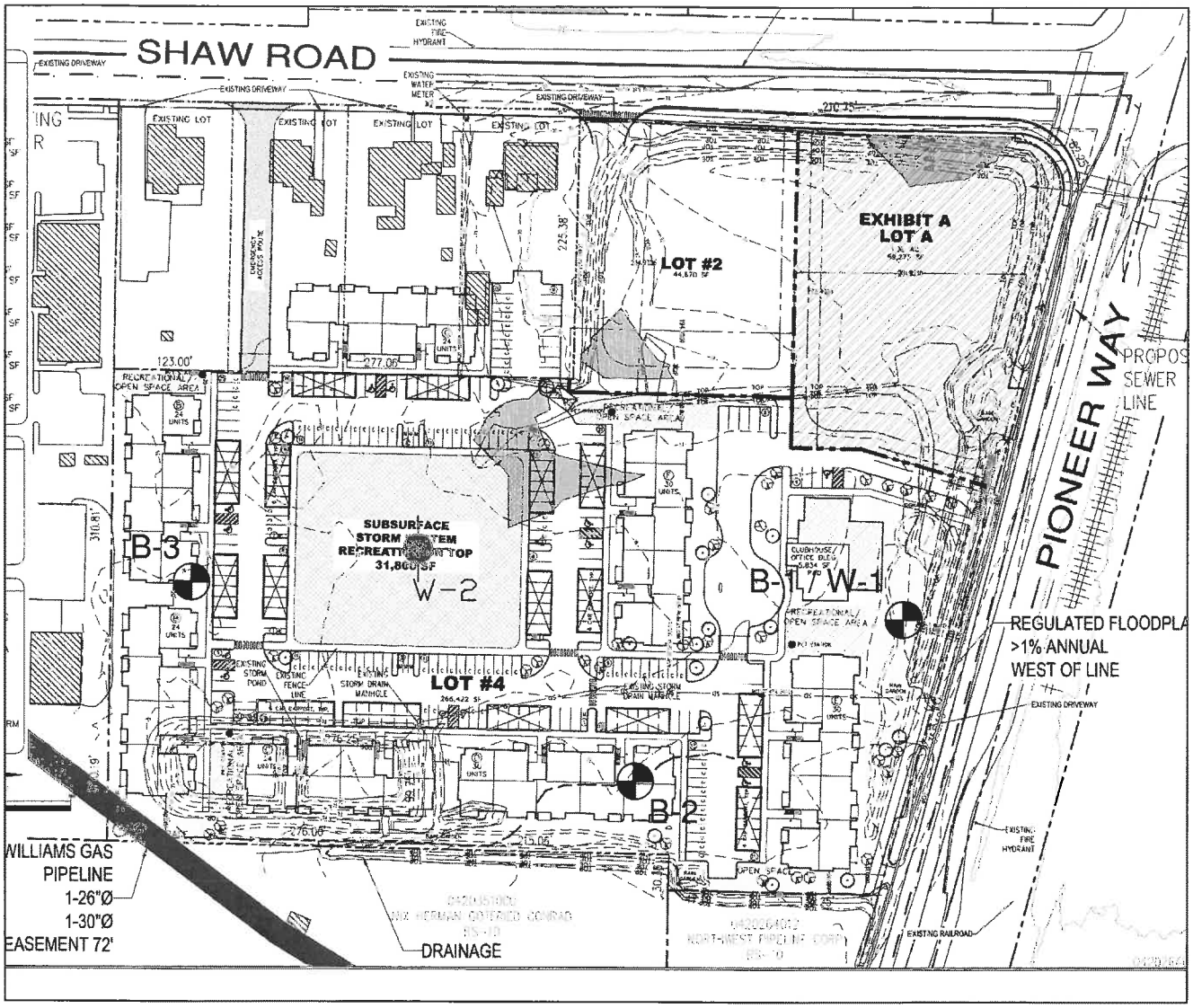
Figure 1

Drawn By: T. Nunan

Date: April 2019

Krazan & ASSOCIATES, INC.

Not to Scale



LEGEND

B-1 Number and Approximate Location of Borings

W-1 Approximate Location of Monitoring Well

N

Reference: Plan Sheet titled "Overall Site Plan", prepared by Abbey Road Group dated December 7, 2018.

Site Plan

East Town Crossing	Figure 2
Shaw Rd & E Pioneer Way, Puyallup, WA	
Project Number: 062-19007	Drawn By: T. Nunan Date: April 2019
Krazan & ASSOCIATES, INC.	Not to Scale

APPENDIX A

FIELD INVESTIGATION AND LABORATORY TESTING

Field Investigation

The field investigation consisted of a surface reconnaissance and a subsurface exploration program. Exploratory borings and monitoring wells were drilled and sampled for subsurface exploration at this site. The soil explorations reached depths of approximately 38.5 feet below the existing ground surface. The approximate exploratory boring locations are shown on the Site Plan (Figure 2). The logs of the soil explorations and monitoring wells are presented in this appendix. The depths shown on the attached logs are from the existing ground surface at the time of our exploration.

The drilled borings were advanced using a subcontracted drilling rig. Soil samples were obtained by using the Standard Penetration Test (SPT) as described in ASTM Test Method D1586. The Standard Penetration Test and sampling method consists of driving a standard 2-inch outside-diameter, split barrel sampler into the subsoil with a 140-pound hammer free falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the Standard Penetration Resistance, or N-value. The blow count is presented graphically on the boring logs in this appendix. The resistance, or "N" value, provides a measure of the relative density of granular soils or of the relative consistency of cohesive soils.

The soils encountered were logged in the field during the exploration and are described in general accordance with the Unified Soil Classification System (USCS). All samples were returned to our laboratory for evaluation.

Laboratory Testing

The laboratory testing program was developed primarily to determine the index properties of the soils. Test results were used for soil classification and as criteria for determining the engineering suitability of the surface and subsurface materials encountered.

Krazan & ASSOCIATES, INC.

Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.**	**B-1**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat	
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers	
Notes: Monitoring Well W-1 installed in borehole.	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual	
Ground Surface Elevation: 72 +/- feet MSL	**Groundwater Depth:** 8 feet	**Groundwater Elev.:**	**Total Depth of Boring:** 21.5 ft.	

Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
		SPT	1-1	1 6 9	15		Brown Silty SAND (SM), trace gravel and very thin roots, with occassional 6 to 8-inch thick stiff sandy clay layers, medium dense, moist	
							Brownsih Grey Poorly Graded SAND (SP), fine grained, medium dense, moist	
	5	SPT	1-2A 1-2B	4 5 5	10		Alternating 4 to 12-inch thick layers of brown Sandy SILT (ML) and Silty SAND (SM), medium stiff/loose, moist to wet	% Si/Cl = 78.5 % MC = 35.4
		SPT	1-3A 1-3B	1 1/12"	1/12"		Dark Brownish Grey Silty CLAY (CL) with marsh grass, seams of peat and thin roots, very soft, wet - - - Becomes Clayey SILT (ML), with fine sand and thin roots, very soft	LL = 35 PI = 1 % F. Sa = 19.8 % Si/Cl = 79.1 % MC = 51.2
	10	SPT	1-4	1 2 6	8			
							Dark Grey/Black Silty SAND (SM), fine to medium grained, loose, wet	
	15	SPT	1-5	5 4 4	8		- - - Same	
	20	SPT	1-6	4 12 12	24		- - - Becomes Poorly Graded SAND (SP-SM) with Silt, fine to medium grained, medium dense, wet	
							End of Boring at 21.5 Feet	
	25							

Krazan & ASSOCIATES, INC.

Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.**	**B-2**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat	
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers	
Notes:	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual	
Ground Surface Elevation: 73 +/- feet MSL	**Groundwater Depth:** 8 feet	**Groundwater Elev.:**	**Total Depth of Boring:** 38.5 ft.	

Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
							5 inches Grass and Topsoil	
		SPT	2-1	2 2 5	7		Brown Silty SAND (SM), fine grained, with occassional sandy clay seams, loose, moist	
	5	SPT	2-2	3 4 2	6		- - - Same	% Si/Cl = 42.9 % MC = 29.3
		SPT	2-3	4 8 11	19		Brownish Grey Sandy SILT (ML), fine grained, with occassional 1 to 2-inch thick seams dark grey fine sand, moist to wet, stiff	% Si/Cl = 88.2 % MC = 37.0
	10	SPT	2-4	5 8 8	16		Dark Grey/Black Silty SAND (SM), fine to medium grained, medium dense, wet	% Si/Cl = 14.5 % MC = 25.0
	15	SPT	2-5	28 12 12	24		- - - Becomes Sand (SP-SM) with Silt, fine to medium grained, medium dense	% Grav = 0 % Sa = 90.8 % Si/Cl = 8.9 % MC = 22.6
							- - - At 18 feet, drilling choppy due to lots of gravel	
	20	SPT	2-6	18 40 20/8"	60/8"		Dark Grey/Black Poorly Graded GRAVEL (GP-GM) with sand and silt, very dense, wet	
	25							

Krazan & ASSOCIATES, INC.

Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.** B-2
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers
Notes:	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual
Ground Surface Elevation: 73 +/- feet MSL	**Groundwater Depth:** 8 feet	**Groundwater Elev.:**	**Total Depth of Boring:** 38.5 ft.

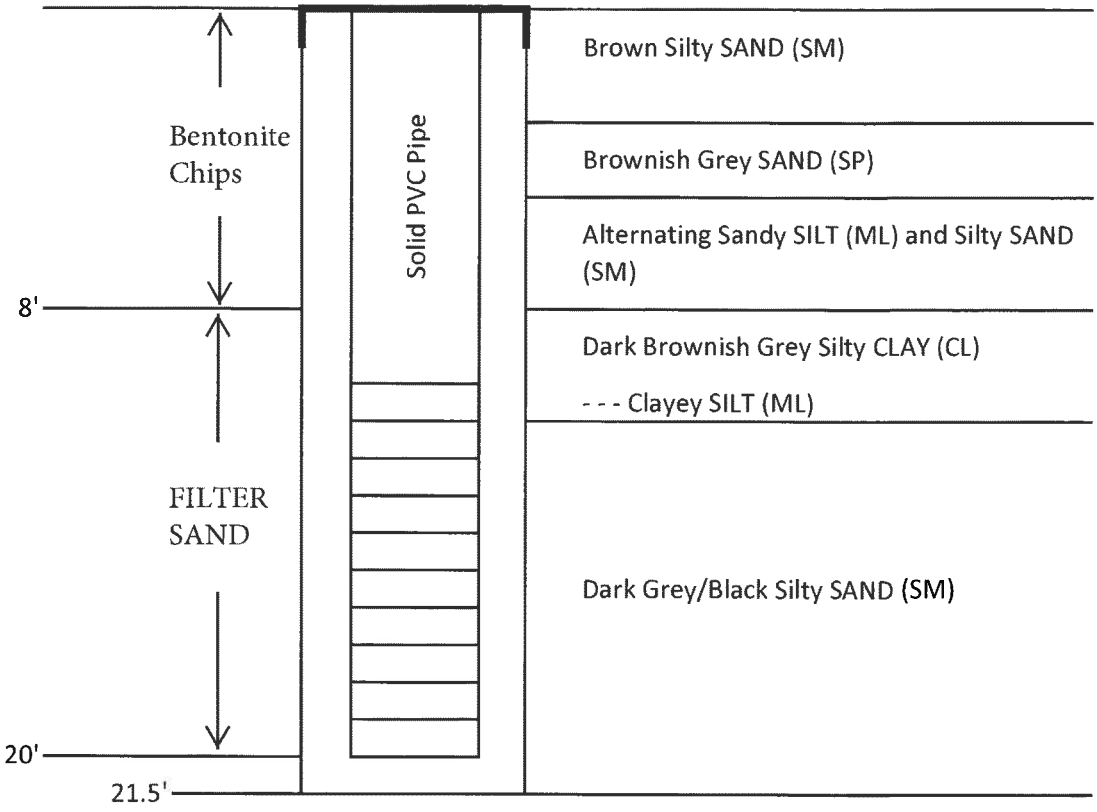
Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
	25	SPT	2-7	10 9 14	23		Dark Grey SAND (SP-SM) with Silt, trace gravel, fine to coarse grained, with occassional 3 to 4-inch thick seams gravel (GP-GM) with silt, medium dense, wet	
	30	SPT	2-8	4 4 15	19		- - - Same	% Grav = 9.0 % Sa = 82.5 % Si/Cl = 8.5 % MC = 18.8
	35	SPT	2-9	6 5 10	15		At 33 feet, alternating 4 to 12-inch thick layers of Dark Grey/Black SAND (SP-SM) with gravel and silt **AND** Dark Grey/Black GRAVEL (GP-GM) with sand and silt, medium dense, wet	% Si/Cl = 5.6 % MC = 18.9
		SPT	2-10	37 20 17	37		- - - Becomes dense	% Grav = 44.8 % Sa = 47.4 % Si/Cl = 7.8 % MC = 9.4
	40						**End of Boring at 38.5 Feet**	
	45							
	50							

Krazan & ASSOCIATES, INC.

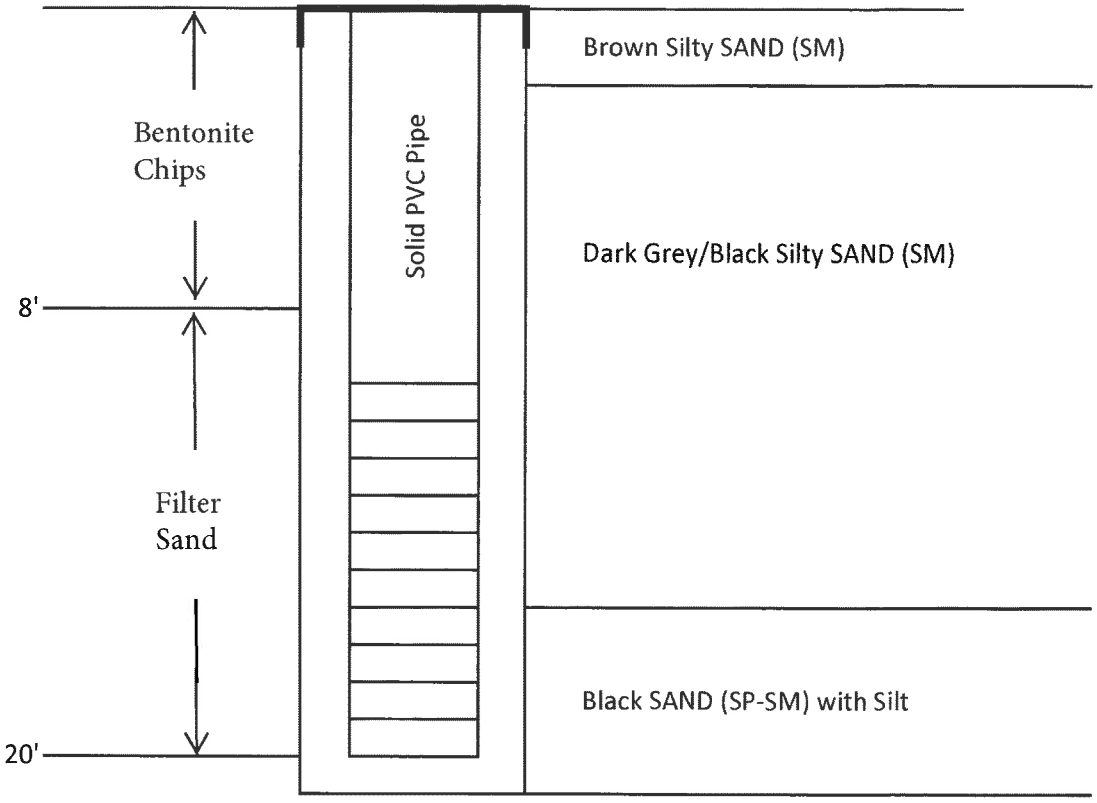
Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.**	**B-3**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat	
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers	
Notes:	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual	
Ground Surface Elevation: 74 +/- feet MSL	**Groundwater Depth:** 7 feet		**Total Depth of Boring:** 21.5 ft.	

Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
		SPT	3-1	2 4 5	9		Brown Silty SAND (SM), trace gravel and very thin roots, with occassional 2 to 3-inch thick stiff sandy clay layers, loose, moist	
	5	SPT	3-2	4 6 6	12		Brownish Grey Sandy SILT (ML), fine grained, with occassional 0.5 to 2-inch thick seams dark grey fine sand, stiff, moist to wet, stiff	
		SPT	3-3	5 5 5	10		Dark Grey/Black Silty SAND (SM), fine to medium grained, medium dense, wet	
	10	SPT	3-4	3 5 7	12		- - - Becomes Sand (SP-SM) with Silt, fine to medium grained, medium dense, wet	
	15	SPT	3-5	6 10 7	17		Dark Grey/Black Silty SAND (SM), fine to medium grained, with a 4-inch thick seam of peat at 20 feet, medium dense, wet	
	20	SPT	3-6	4 6 8	14		**End of Boring at 21.5 Feet**	
	25							

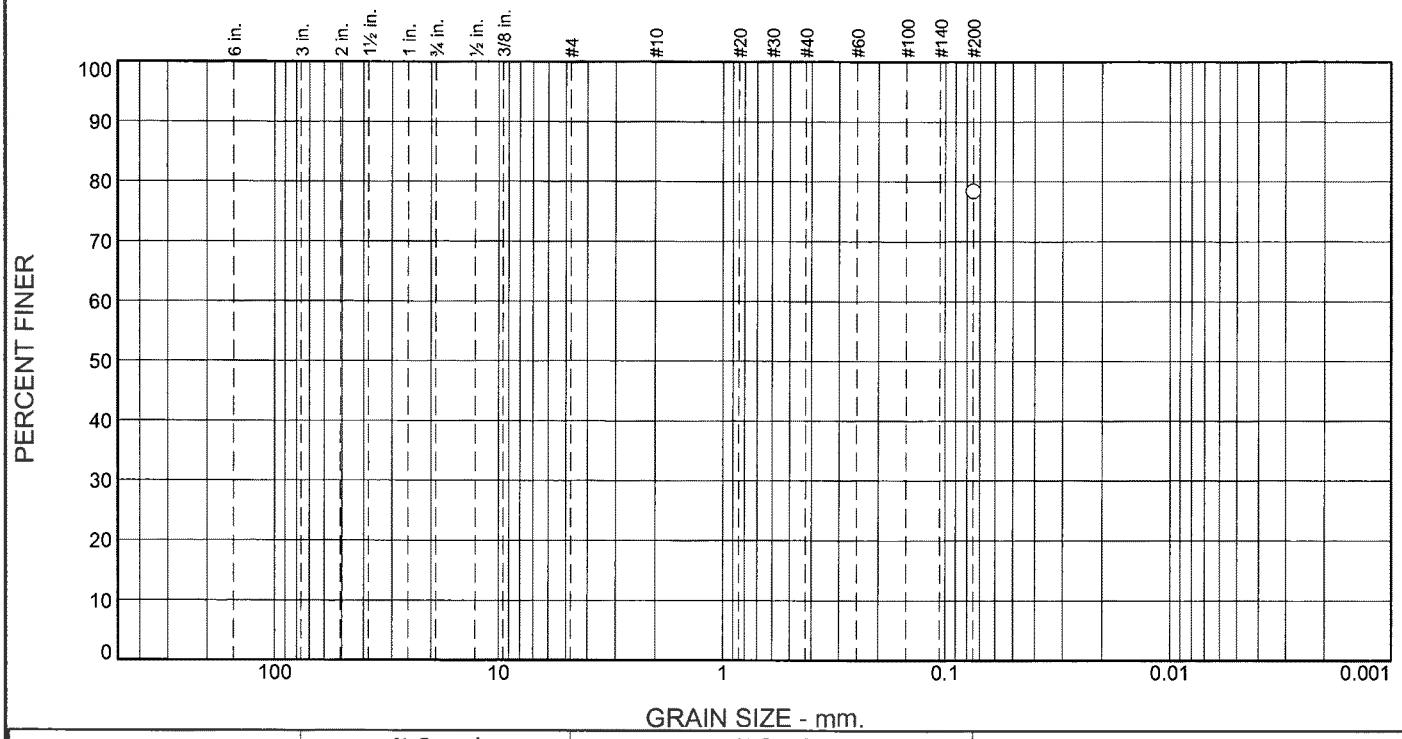
Monitoring Well
MW-1



Monitoring Well
MW-2



Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						78.5

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	78.5		

* (no specification provided)

Material Description

Brown Sandy SILT

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= ML AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L131
Sample Date:3-11-19
Moisture Content = 35.4 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-1 Sample 1-2B
Sample Number: 19L131 **Depth:** 5'-6.5'

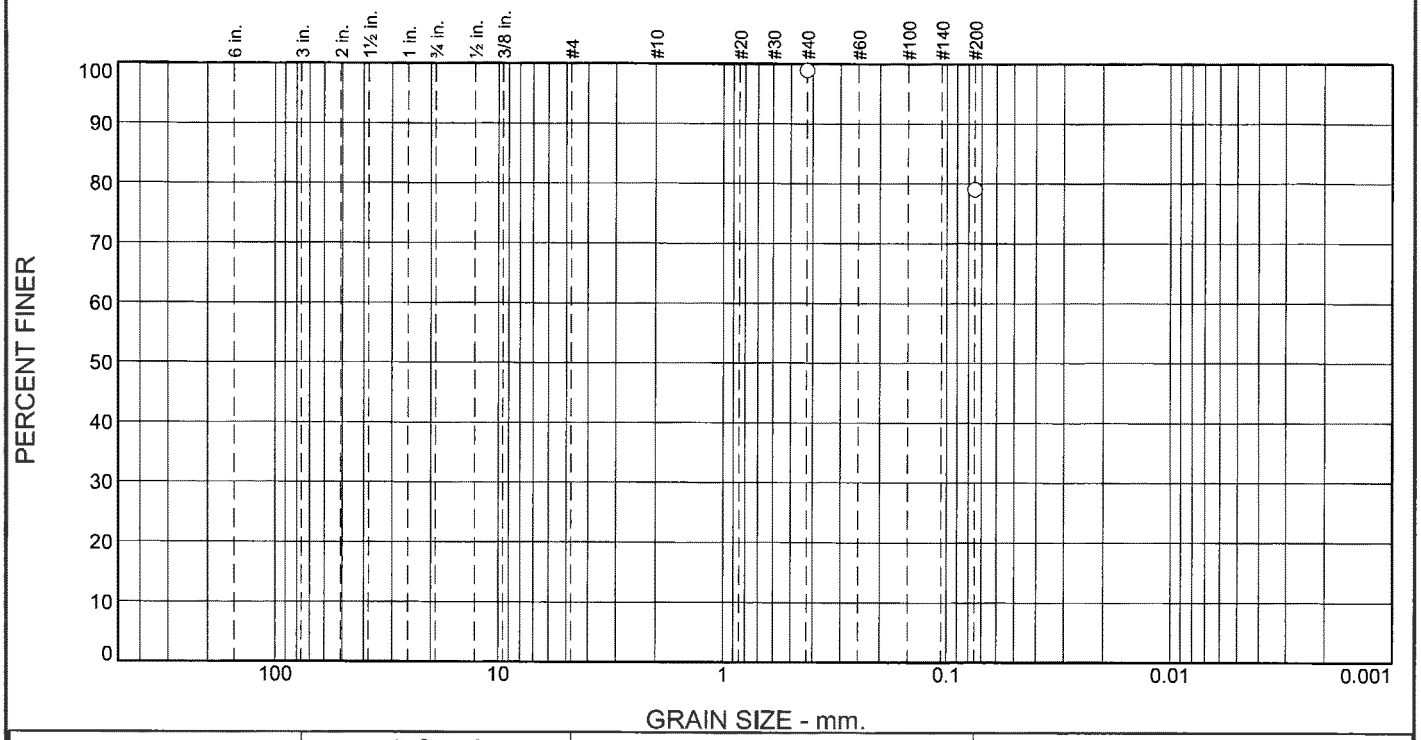
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
					19.8	79.1

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#40	98.9		
#200	79.1		

* (no specification provided)

Material Description

Grey Clayey SILT with fine sand

Atterberg Limits (ASTM D 4318)

PL= 33.5 LL= 34.9 PI= 1.4

Classification

USCS (D 2487)= ML AASHTO (M 145)=

Coefficients

D_{90}= 0.1948 D_{85}= 0.1258 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L120
Sample Date:3-11-19
Moisture Content = 51.2 %

Date Received: 3-15-19 **Date Tested:** 3-15-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-1 Sample 1-3B
Sample Number: 19L120 **Depth:** 7.5'-9'

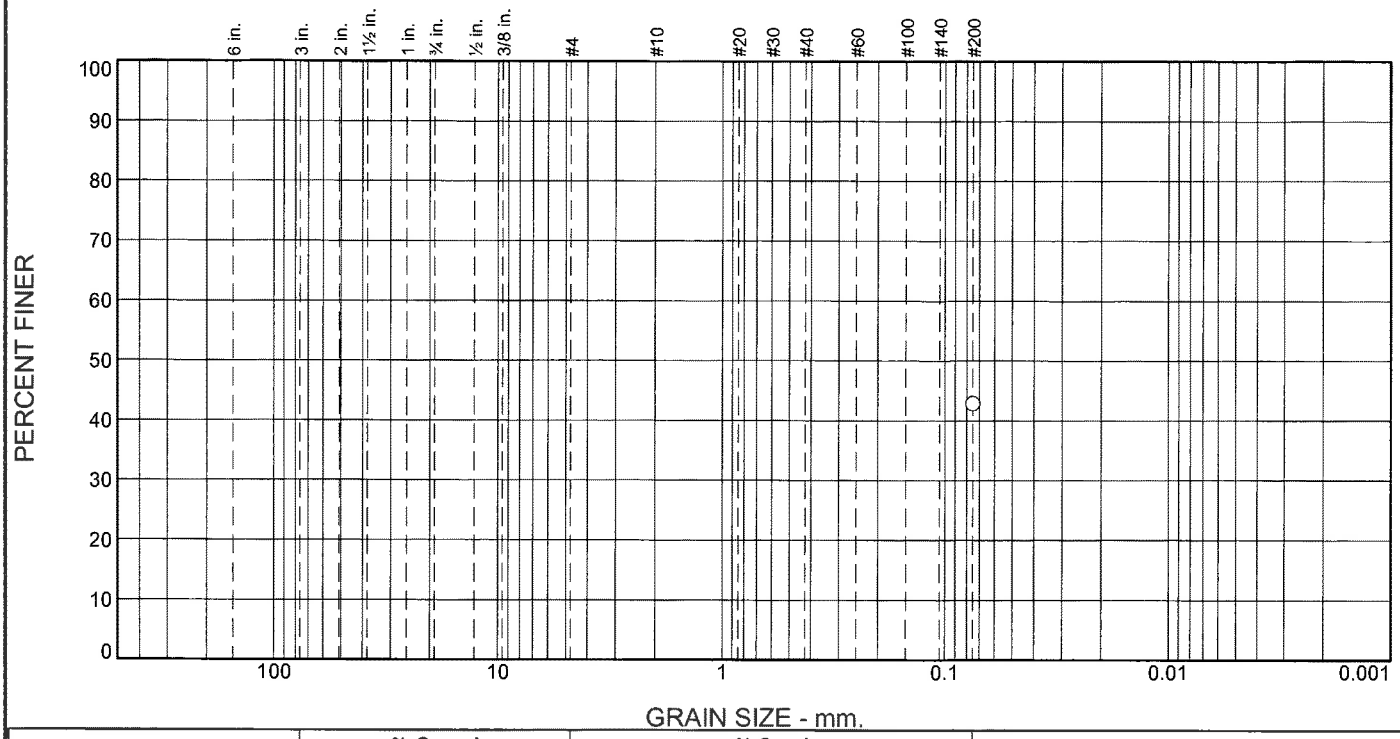
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						42.9

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	42.9		

* (no specification provided)

Material Description

Brown silty sand.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L132
Sample Date:3-11-19
Moisture Content = 29.3 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-2
Sample Number: 19L132 **Depth:** 5'-6.5'

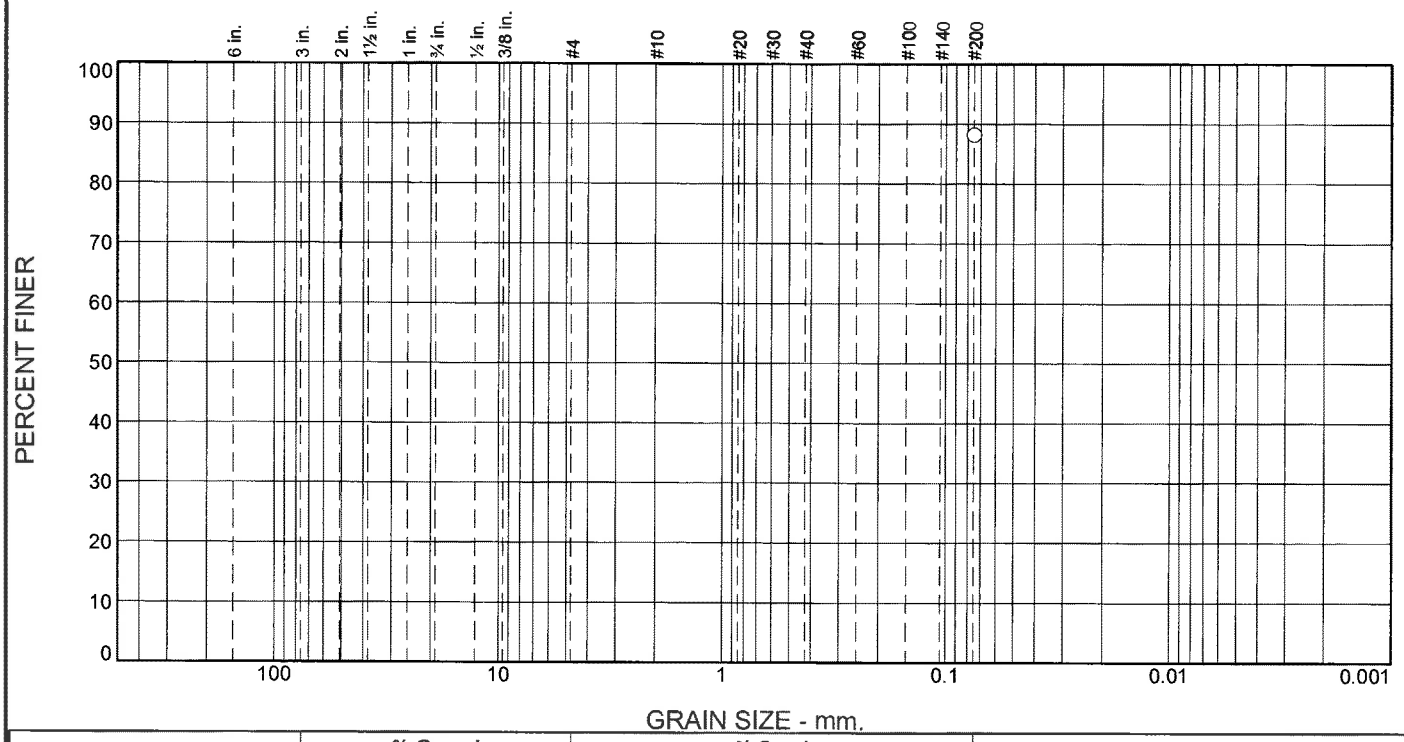
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						88.2

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	88.2		

* (no specification provided)

Material Description

Brown sandy silt.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= ML AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L133
Sample Date:3-11-19
Moisture Content = 37.0%

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-3
Sample Number: 19L133 **Depth:** 7.5'-9'

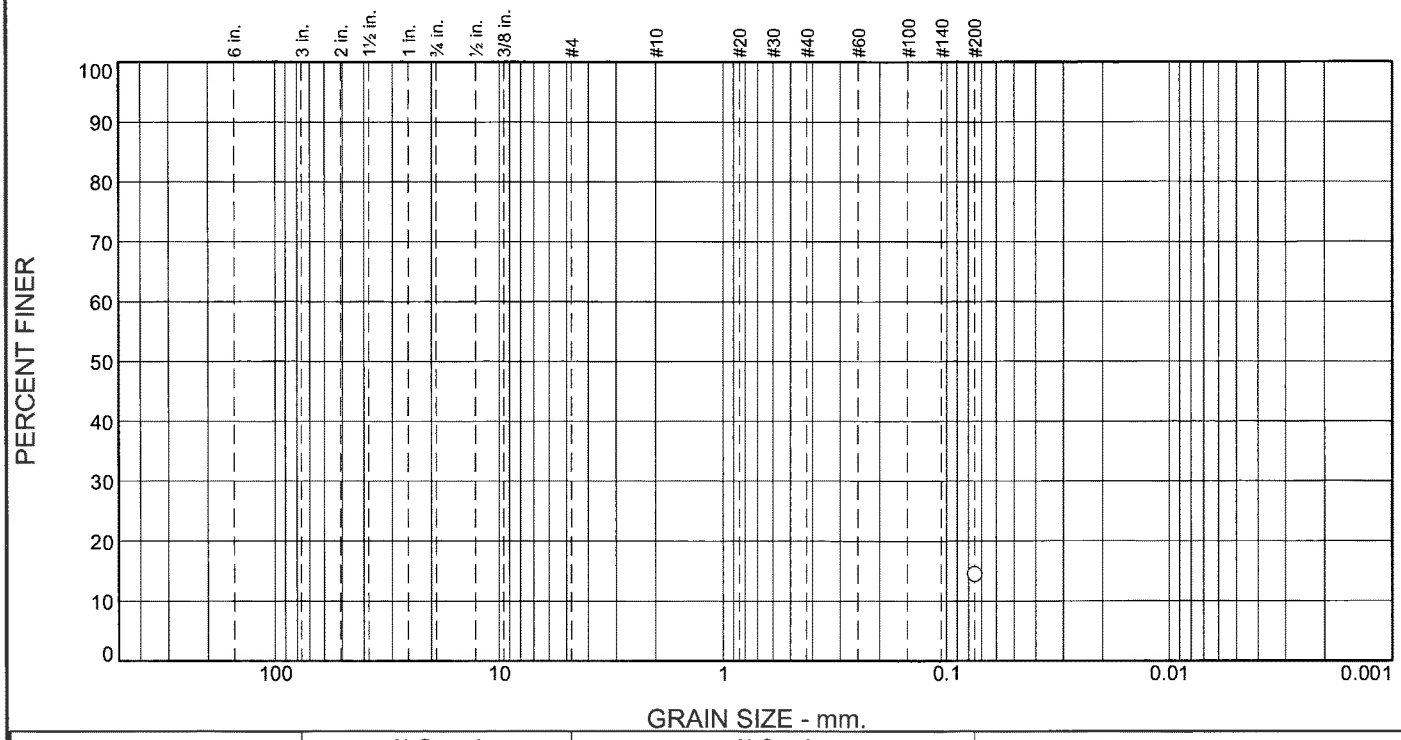
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						14.5

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	14.5		

* (no specification provided)

Material Description

Dark Grey/Black silty sand.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L134
sample Date:3-11-19
Moisture Content = 25.0 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-4
Sample Number: 19L134 **Depth:** 10'-11.5' **Date Sampled:** 3-11-19

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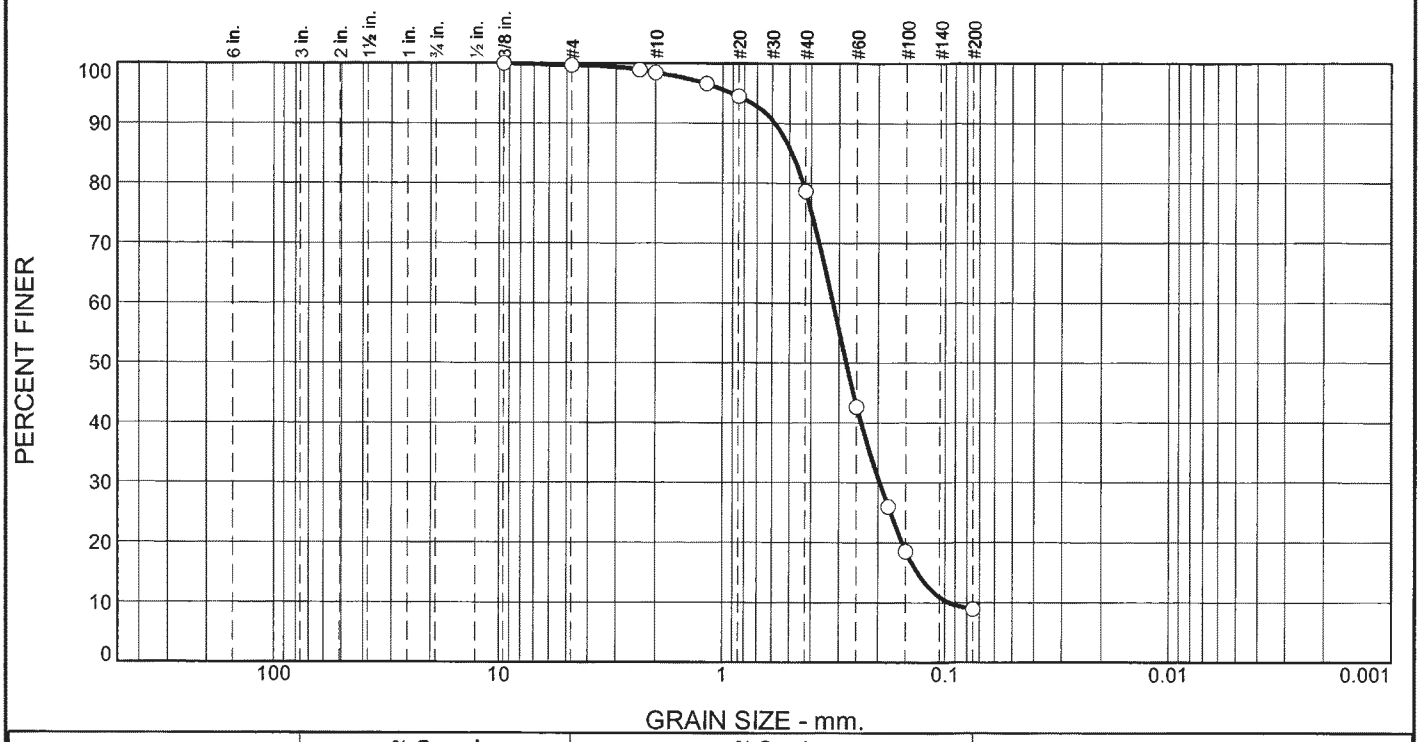
Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.3	1.2	19.8	69.8	8.9

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.375	100.0		
#4	99.7		
#8	98.9		
#10	98.5		
#16	96.6		
#20	94.5		
#40	78.7		
#60	42.7		
#80	26.0		
#100	18.5		
#200	8.9		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.5827 D_{85}= 0.4892 D_{60}= 0.3205
D_{50}= 0.2792 D_{30}= 0.1966 D_{15}= 0.1334
D_{10}= 0.0956 C_u= 3.35 C_c= 1.26

Remarks

Sample ID:19L121
Sample Date:3-11-19
Moisture Content = 22.6 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials laboratory Manager

Location: B-2 Sample 2-5
Sample Number: 19L121 **Depth:** 15'-16.5'

Date Sampled: 3-11-19

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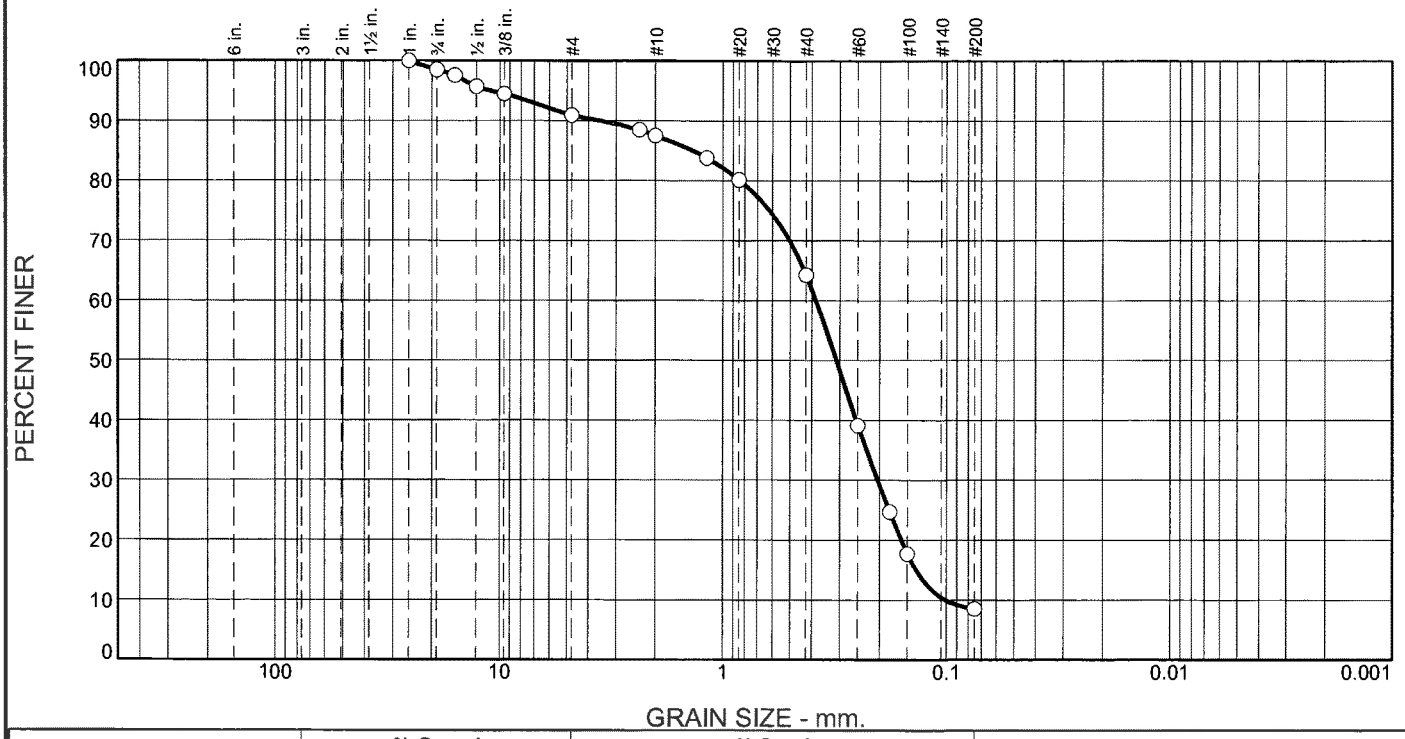
Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	1.4	7.6	3.5	23.3	55.7	8.5

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	98.6		
.625	97.6		
.5	95.7		
.375	94.5		
#4	91.0		
#8	88.5		
#10	87.5		
#16	83.8		
#20	80.2		
#40	64.2		
#60	39.1		
#80	24.7		
#100	17.7		
#200	8.5		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 3.5671 D_{85}= 1.3567 D_{60}= 0.3839
D_{50}= 0.3115 D_{30}= 0.2039 D_{15}= 0.1371
D_{10}= 0.1011 C_u= 3.80 C_c= 1.07

Remarks

Sample ID:19L122
Sample Date:3-11-19
Moisture Content = 18.8 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-8
Sample Number: 19L122 **Depth:** 30'-31.5'

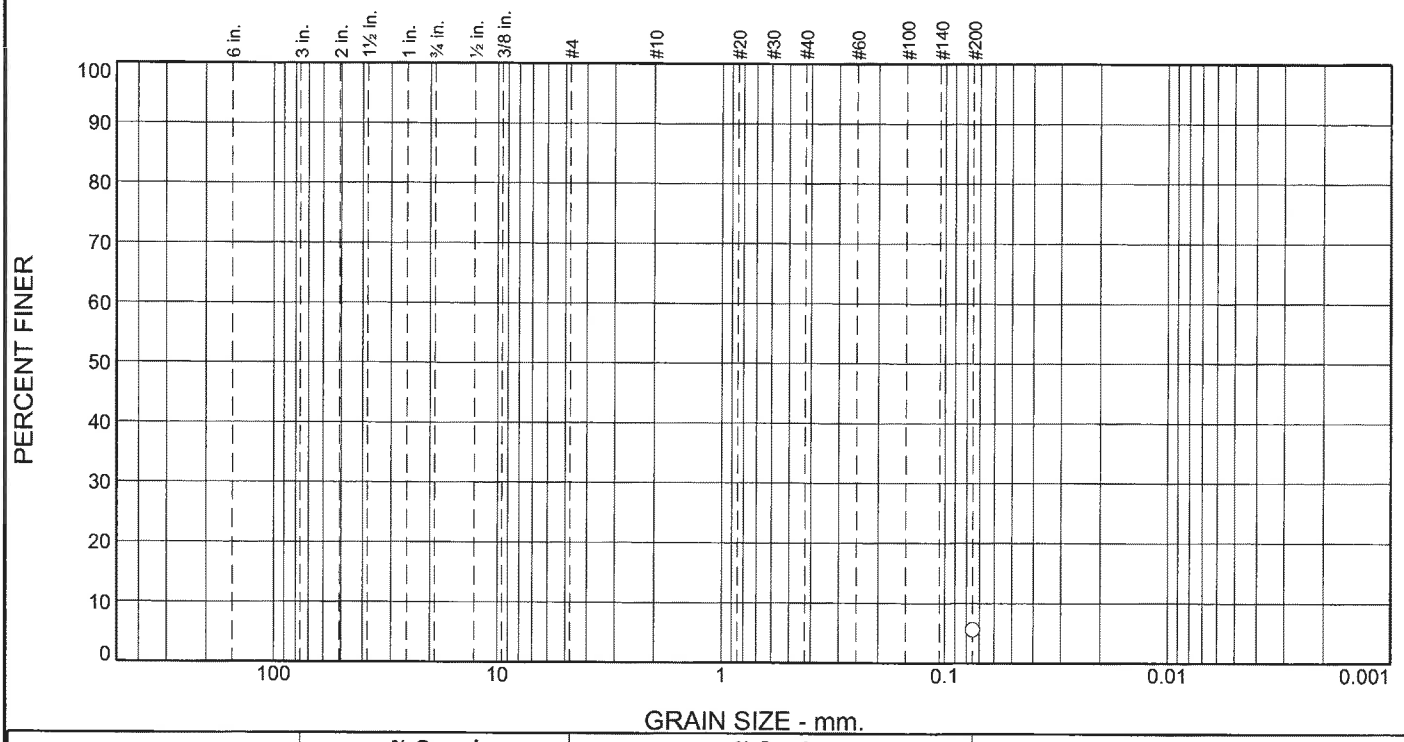
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						5.6

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	5.6		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L135
Sample Date:3-11-19
Moisture Content = 18.9 %

Date Received: 3-15-19 **Date Tested:** 3-11-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-9
Sample Number: 19L135 **Depth:** 35'-36.5'

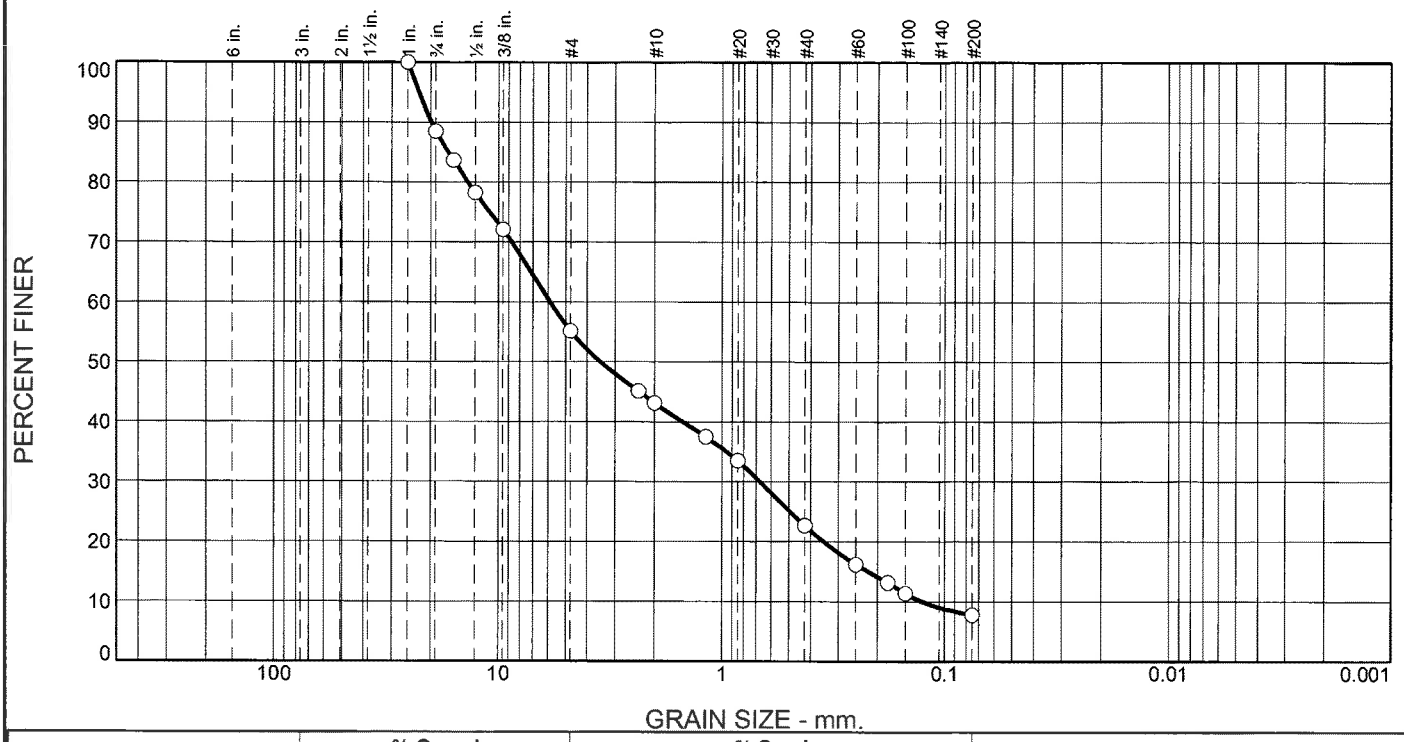
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	11.5	33.3	12.0	20.5	14.9	7.8

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	88.5		
.625	83.7		
.5	78.3		
.375	72.1		
#4	55.2		
#8	45.1		
#10	43.2		
#16	37.5		
#20	33.5		
#40	22.7		
#60	16.2		
#80	13.2		
#100	11.4		
#200	7.8		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt and gravel.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 19.9452 D_{85}= 16.7747 D_{60}= 5.8717
D_{50}= 3.4968 D_{30}= 0.6741 D_{15}= 0.2194
D_{10}= 0.1253 C_u= 46.85 C_c= 0.62

Remarks

Sample ID:19L123
Sample Date:3-11-19
Moisture Content = 9.4 %

Date Received: 3-11-19 **Date Tested:** 3-11-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-10
Sample Number: 19L123 **Depth:** 37'-38.5'

Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

APPENDIX B

EARTHWORK SPECIFICATIONS

GENERAL

When the text of the report conflicts with the general specifications in this appendix, **the recommendations in the report have precedence**.

SCOPE OF WORK: These specifications and applicable plans pertain to and include all earthwork associated with the site rough grading, including but not limited to the furnishing of all labor, tools, and equipment necessary for site clearing and grubbing, stripping, preparation of foundation materials for receiving fill, excavation, processing, placement and compaction of fill and backfill materials to the lines and grades shown on the project grading plans, and disposal of excess materials.

PERFORMANCE: The Contractor shall be responsible for the satisfactory completion of all earthwork in accordance with the project plans and specifications. This work shall be inspected and tested by a representative of Krazan and Associates, Inc., hereinafter known as the Geotechnical Engineer and/or Testing Agency. Attainment of design grades when achieved shall be certified by the project Civil Engineer. Both the Geotechnical Engineer and Civil Engineer are the Owner's representatives. If the contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory as determined by both the Geotechnical Engineer and Civil Engineer. No deviation from these specifications shall be made except upon written approval of the Geotechnical Engineer, Civil Engineer, or project Architect.

No earthwork shall be performed without the physical presence or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least 2 working days prior to the commencement of any aspect of the site earthwork.

The Contractor agrees that he shall assume sole and complete responsibility for job site conditions during the course of construction of this project, including safety of all persons and property; that this requirement shall apply continuously and not be limited to normal working hours; and that the Contractor shall defend, indemnify and hold the Owner and the Engineers harmless from any and all liability, real or alleged, in connection with the performance of work on this project, except for liability arising from the sole negligence of the Owner or the Engineers.

TECHNICAL REQUIREMENTS: All compacted materials shall be densified to a density of not less than 95 percent of maximum dry density as determined by ASTM Test Method D1557 as specified in the technical portion of the Geotechnical Engineering Report. The results of these tests and compliance with these specifications shall be the basis upon which satisfactory completion of work will be judged by the Geotechnical Engineer.

SOIL AND FOUNDATION CONDITIONS: The Contractor is presumed to have visited the site and to have familiarized himself with existing site conditions and the contents of the data presented in the soil report.

The Contractor shall make his own interpretation of the data contained in said report, and the Contractor shall not be relieved of liability under the contractor for any loss sustained as a result of any variance between conditions indicated by or deduced from said report and the actual conditions encountered during the progress of the work.

DUST CONTROL: The work includes dust control as required for the alleviation or prevention of any dust nuisance on or about the site or the borrow area, or off-site if caused by the Contractor's operation either during the performance of the earthwork or resulting from the conditions in which the Contractor leaves the site. The Contractor shall assume all liability, including Court costs of codefendants, for all claims related to dust or windblown materials attributable to his work.

SITE PREPARATION

General site clearing should include removal of any organics, asphaltic concrete, abandoned utilities, structures including foundations, basement walls and floors, rubble, and rubbish. After stripping operations and removal of any loose and/or debris-laden fill, the exposed subgrade should be visually inspected and/or proof rolled to identify any soft/loose areas.

SUBGRADE PREPARATION: Subgrade should be prepared as described in our site preparation section of this report.

EXCAVATION: All excavation shall be accomplished to the tolerance normally defined by the Civil Engineer as shown on the project grading plans. All over excavation below the grades specified shall be backfilled at the Contractor's expense and shall be compacted in accordance with the applicable technical requirements.

FILL AND BACKFILL MATERIAL: No material shall be moved or compacted without the presence of the Geotechnical Engineer. Material from the required site excavation may be utilized for construction site fills provided prior approval is given by the Geotechnical Engineer. All materials utilized for constructing site fills shall be free from vegetable or other deleterious matter as determined by the Geotechnical Engineer.

PLACEMENT, SPREADING, AND COMPACTION: The placement and spreading of approved fill materials and the processing and compaction of approved fill and native materials shall be the responsibility of the Contractor. However, compaction of fill materials by flooding, ponding, or jetting shall not be permitted unless specifically approved by local code, as well as the Geotechnical Engineer.

Both cut and fill shall be surface compacted to the satisfaction of the Geotechnical Engineer prior to final acceptance.

SEASONAL LIMITS: No fill material shall be placed, spread, or rolled while it is frozen or thawing or during unfavorable wet weather conditions. When the work is interrupted by heavy rains, fill operations shall not be resumed until the Geotechnical Engineer indicates that the moisture content and density of previously placed fill are as specified.

APPENDIX C

PAVEMENT SPECIFICATIONS

1. **DEFINITIONS** – The term "pavement" shall include asphalt concrete surfacing, untreated aggregate base, and aggregate subbase. The term "subgrade" is that portion of the area on which surfacing, base, or subbase is to be placed.

2. **SCOPE OF WORK** – This portion of the work shall include all labor, materials, tools, and equipment necessary for and reasonably incidental to the completion of the pavement shown on the plans and as herein specified, except work specifically notes as "Work Not Included."

3. **PREPARATION OF THE SUBGRADE** – Subgrade should be prepared as described in our site preparation and pavement design sections of this report.

4. **AGGREGATE BASE** – The aggregate base shall be spread and compacted on the prepared subgrade in conformity with the lines, grades, and dimensions shown on the plans. The aggregate base should conform to WSDOT Standard Specification for Crushed Surfacing Base Course or Top Course (Item 9-03.9(3)). The base material shall be compacted to a minimum compaction of 95% as determined by ASTM D1557. Each layer of subbase shall be tested and approved by the Geotechnical Engineer prior to the placement of successive layers.

5. **ASPHALTIC CONCRETE SURFACING** – Asphaltic concrete surfacing shall consist of a mixture of mineral aggregate and paving grade asphalt, mixed at a central mixing plant and spread and compacted on a prepared base in conformity with the lines, grades, and dimensions shown on the plans. The drying, proportioning, and mixing of the materials shall conform to WSDOT Specifications.

The prime coat, spreading and compaction equipment, as well as the process of spreading and compacting the mixture, shall conform to WSDOT Specifications, with the exception that no surface course shall be placed when the atmospheric temperature is below 50 degrees F. The surfacing shall be rolled with combination steel-wheel and pneumatic rollers, as described in WSDOT Specifications. The surface course shall be placed with an approved self-propelled mechanical spreading and finishing machine.

6. **TACK COAT** – The tack (mixing type asphaltic emulsion) shall conform to and be applied in accordance with the requirements of WSDOT Specifications.

Steep Slope Addendum Letter

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

July 31, 2020

KA Project No. 062-190007

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Gil Hulsmann
Email: Gil.Hulsmann@AbbeyRoadGroup.com
Phone: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation Addendum Letter**
East Town Crossing
Parcel Nos. 0420264053, 0420264054, 0420351066
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington 98371

Dear Mr. Hulsmann,

Per your request, we have prepared this letter to provide our opinion regarding the nearby steep slopes. We previously prepared a geotechnical report titled "Geotechnical Engineering Investigation – East Town Crossing – Parcel Nos. 0420264053, 0420264054, 0420351066 – SE Corner of E. Shaw Road & E. Pioneer Way – Puyallup, Washington", dated April 11, 2019.

Based on our communication with you, it is our understanding that the City of Puyallup has requested to provide our opinion on the hazards and risks to the site due to the site being within 300 feet of steep slopes.

We have reviewed Washington State Department of Natural Resources (DNR), City of Puyallup, and Pierce County published landslide hazard maps and web data. We have also reviewed the Landslide Inventory, Susceptibility, and Exposure Analysis of Pierce County, Washington (DNR), prepared by Katherine A. Mickelson et al., and dated July 2017.

Based on our review, we understand that steep slopes are located roughly 300 feet to the south and east from the site. These nearby slopes are mapped moderate to high for shallow landslide susceptibility, and moderate for deep susceptibility. However, there are no historic landslides or debris mapped at the nearby slopes. The closest landslide mapped is located roughly 1 mile southeast of the site.

There is an existing developed property between the nearby southern slope and the southern boundary of the site. There is a partially developed property between the nearby eastern slope and the eastern boundary of the site. In our opinion, these properties to the south and east create a buffer between the nearby slopes

and the site. Based on our review of available published documents and maps, it is our opinion that there is minimum to no risk to the planned development from the nearby slopes.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,

KRAZAN & ASSOCIATES, INC.

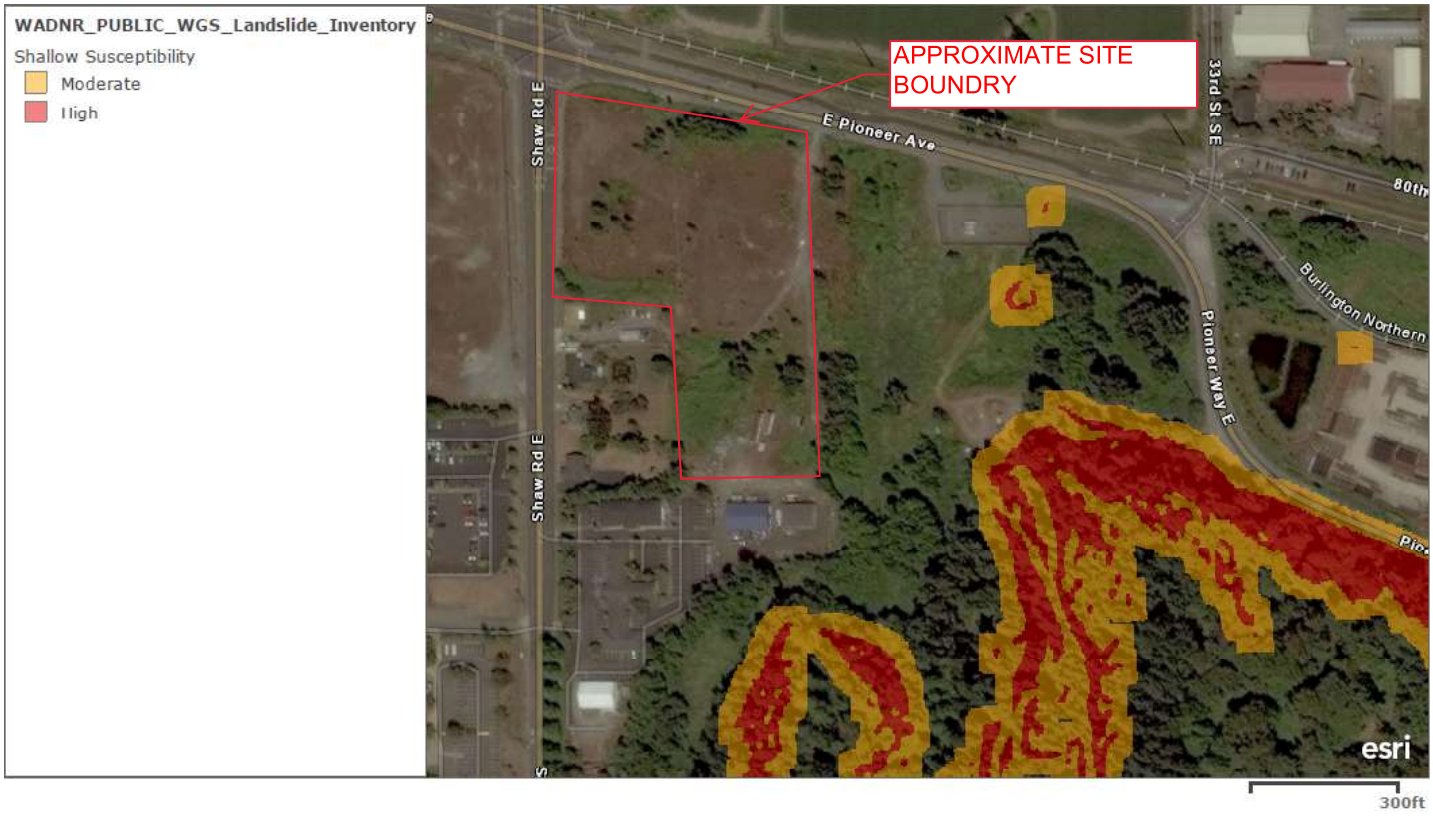
07/31/20

Vijay Chaudhary, P.E.
Project Engineer

Theresa Nunan

Theresa R. Nunan
Project Manager

Attachments: WA DNR Landslide Inventory Maps (Figures A, B, and C)



USDA FSA, GeoEye, Maxar | Esri Community Maps Contributors, King County, WA State Parks GIS, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

N

Krazan

East Town Crossing

Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: A	Not to scale

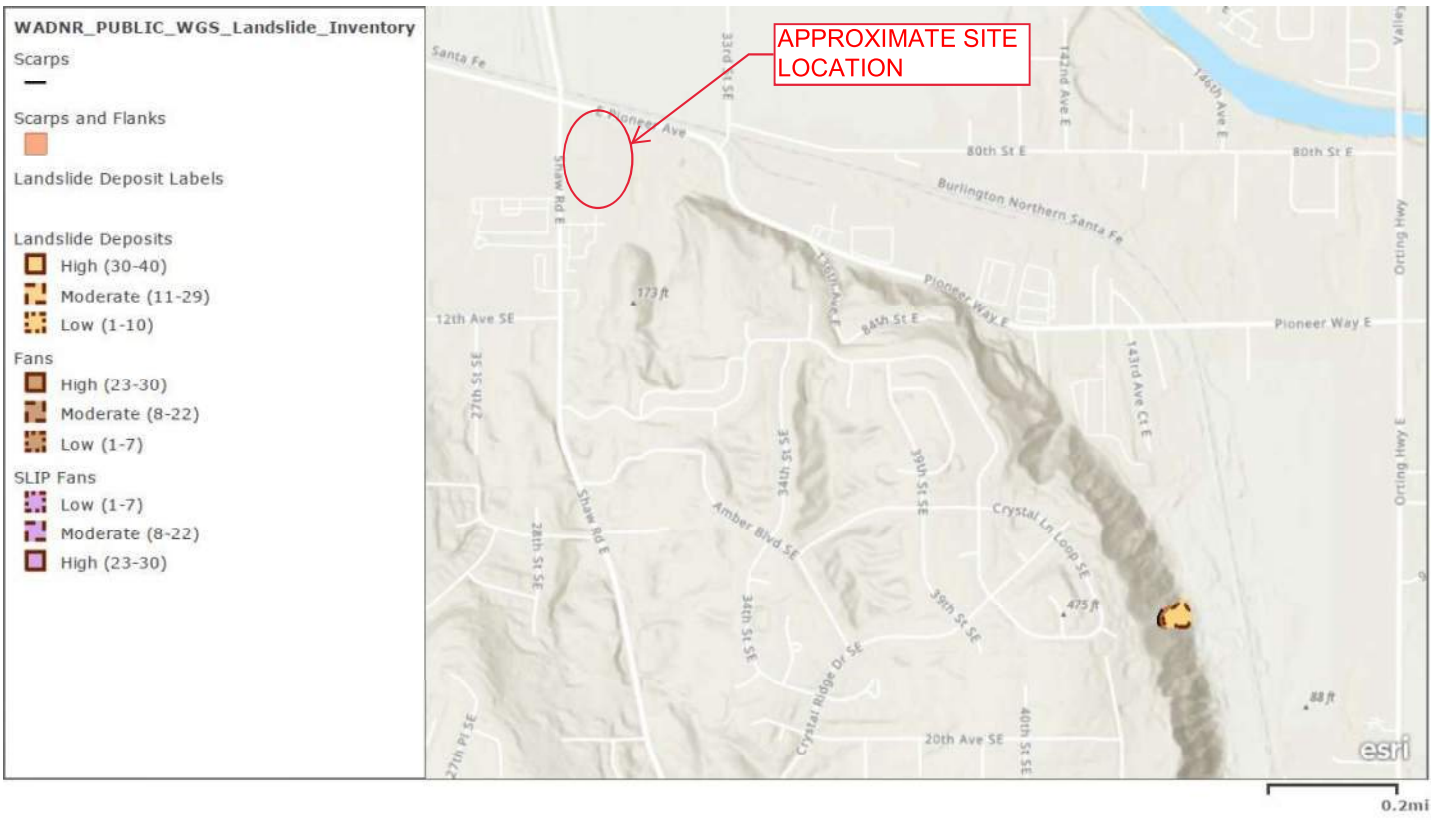
USDA FSA, GeoEye, Maxar | Esri Community Maps Contributors, King County, WA State Parks GIS, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

N

Krazan

East Town Crossing

Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: B	Not to scale



Esri, NASA, NGA, USGS, FEMA | Esri Community Maps Contributors, King County, WA State Parks GIS, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

N

Krazan

East Town Crossing

Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: C	Not to scale

Figure A6 - Geo-technical Infiltration Report

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

March 19, 2021

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Gil Hulsmann
Email: Gil.Hulsmann@AbbeyRoadGroup.com
Phone: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation Addendum Letter**
East Town Crossing
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington

Dear Mr. Hulsmann,

Per your request, we have prepared this letter to provide the results of two (2) Large-Scale Pilot Infiltration Tests (PITs) we conducted at the above-referenced site. We previously prepared a geotechnical report titled "Geotechnical Engineering Investigation – East Town Crossing – Parcel Nos. 0420264053, 0420264054, 0420351066 – SE Corner of E. Shaw Road & E. Pioneer Way – Puyallup, Washington", dated April 11, 2019, as well as an addendum letter dated July 31, 2020 that addressed the nearby steep slopes.

Large-Scale PITs

Two (2) test pits, designated P-1 and P-2, were excavated near Monitoring Wells MW-1 and MW-2, respectively, on March 4, 2021 at the approximate locations indicated on the Site Plan, Figure 1, in order to conduct large-scale infiltration tests in accordance with the 2014 Stormwater Management Manual for Western Washington (SWMMWW). The infiltration test locations were selected in the field by the client and excavated using a client provided excavator and operator. The bottom of each pit was excavated 10-feet wide by 10-feet long, which met the minimum required horizontal surface area of 100 square feet (sf). Each test pit was initially excavated to a depth of 2 feet below the existing ground surface (bgs), which exposed silty sand (SM) soils at the pit bottom. Water was observed seeping from the sides of pit P-1 during excavation, and was observed ponded at the ground surface at several locations in the vicinity of pit P-1. Test pits P-1 and P-2 encountered undocumented fill to a depth of 1.8 feet and 0.5 feet bgs, respectively, followed by native brown silty sand (SM) with trace gravel and occasional sandy silt and sandy clay seams and layers to the bottom of the test pits. The soils exposed at the PIT test depth were similar to those encountered in the geotechnical borings conducted during our original exploration of the site.

The infiltration test procedure includes a pre-soak period, followed by steady-state and then falling head infiltration rate testing. Each pit was filled with water to a depth of 12 inches above the bottom of the pit for the pre-soak period. After two (2) hours of pre-soak, the water hose was turned off as even just a slight trickle caused the water level in the pit to continue to rise. Water level readings were obtained for an additional 4 hours in pit P-2 with no change in the water level, while the water level in pit P-1 increased ¾-inches which we attributed to seepage from the sides of this pit which were observed during its excavation. Since the water in pits P-1 and P-2 was not infiltrating, we left the pits open overnight, and returned to the site to record the water level. Since it had commenced to rain just prior to our leaving the site, a 5-gallon bucket was left at the location of pit P-2 to obtain an estimate of the amount of rain that fell overnight. We recorded 0.6 inches of rain in the bucket the following morning. On the morning of March 5, 2021, the water level in pit P-1 had risen another 1.2 inches, while the water level in pit P-2 rose about 0.3 inches. Figure 2 includes photos of pits P-1 and P-2 taken on March 5, 2021. The pits were not over-excavated due to the presence of water. The contractor had excavated three test pits within the northwestern corner of the site on March 4, 2021. We observed about 8 to 10 inches of water in the bottom of two of the test pits on March 5, 2021.

Evaluation of Infiltration Feasibility: One of the Site Suitability Criteria (SSC) presented in Section 3.3.7, Volume III, 2014 SWMMWW, **SSC-5 Depth to Bedrock, Water Table, or Impermeable Layer**, states that the base of all infiltration basins or trench systems shall be greater than or equal to 5 feet above the seasonal high-water mark, bedrock (or hardpan), or other low permeability layer. Based on the results of our field exploration and large-scale PITs, the soils at the site contain high silt content and are considered a very low to relatively impermeable layer. Based on the results of our general site assessment and field testing, the low permeability soils encountered at the site do not meet the requirements of Site Suitability Criteria SSC-5 and it is therefore our opinion that onsite infiltration of stormwater using basin or trench system is not considered feasible for the proposed development. **However,** consideration may be given to the use of permeable pavement and other Best Management Practices (BMPs), depending on the final site grading plan.

Limitations

This letter has been prepared for the exclusive use of the Abbey Road Group and their assigns, for the specific application to the site. The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. We emphasize that this letter is valid for this project as outlined above, and should not be used for any other site.

This letter does not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands or other biological conditions. The information presented herein is based upon professional interpretation using standard industry practices and engineering conservatism that we consider proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments.

Within the limitations of scope, schedule and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this letter was prepared. No other warranty, expressed or implied, is made.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,

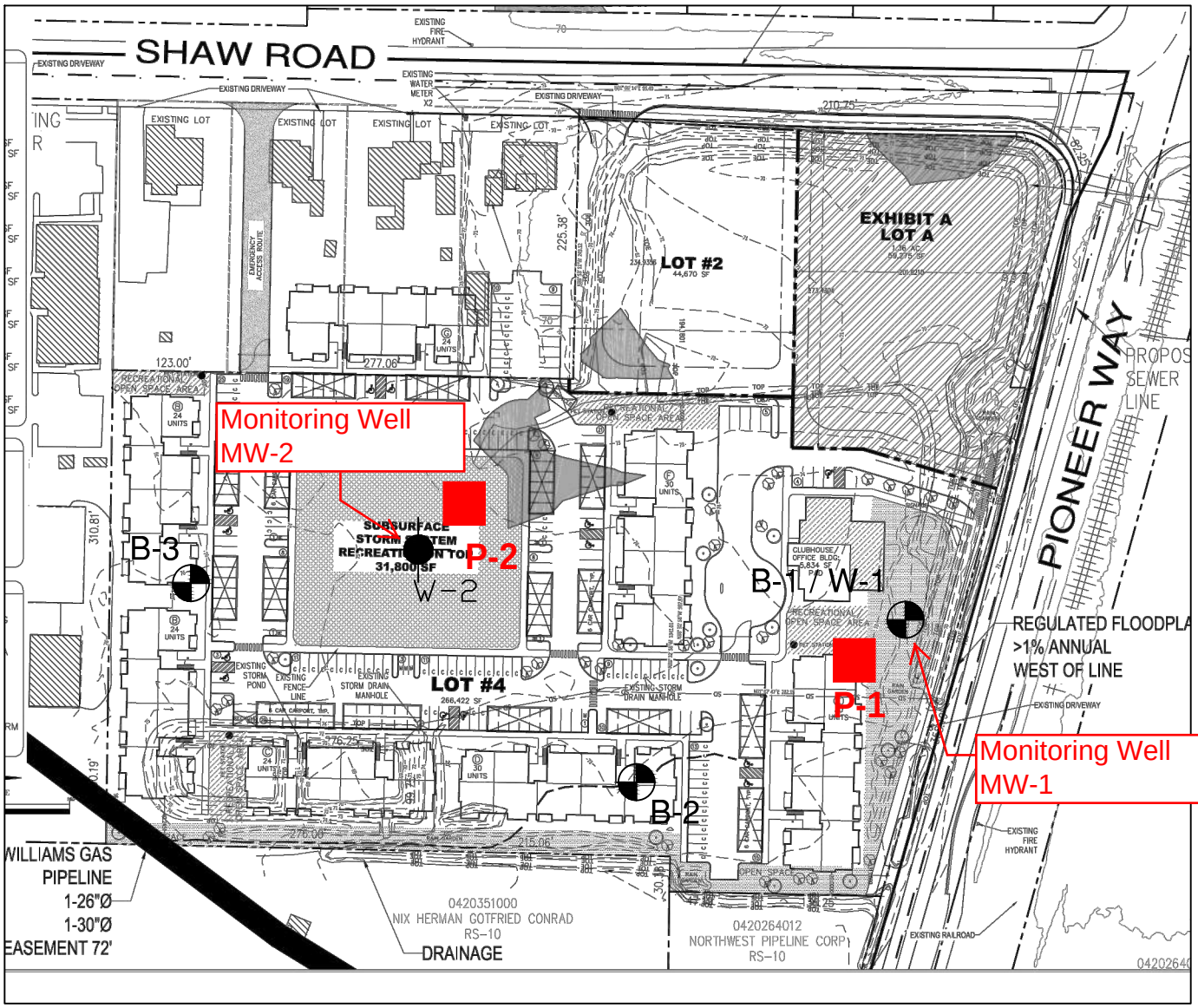
KRAZAN & ASSOCIATES, INC.

3/19/21

Theresa R. Nunan
Project Manager

Vijay Chaudhary, P.E.
Assistant Regional Engineering Manager

Attachments: Figure 1 – Site Plan
Figure 2 – Photos



LEGEND

B-1 Number and Approximate Location of Borings

W-1 Approximate Location of Monitoring Well

P-1 Approximate Location of Pilot Infiltration Test

N

Reference: Plan Sheet titled "Overall Site Plan", prepared by Abbey Road Group dated December 7, 2018.

Site Plan

East Town Crossing

Shaw Rd & E Pioneer Way, Puyallup, WA

Project Number: 062-19007

Figure 1

Drawn By: T. Nunan

Date: March 2021

Krazan & ASSOCIATES, INC.

Not to Scale

Water in Pit P-1 on March 5, 2021.

Water in Pit P-2 on March 5, 2021.

Water in Test Pit on March 5, 2021. Test pit was excavated in NE portion of site on March 4, 2021.

Figure 2 - Photos (March 5, 2021)

Figure A7 - Geo-technical Glass Proctor Report

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

December 10, 2021 KA Project No. 062-21033

Abbey Road Group, LLC
P.O. Box 11489
Olympia, WA 98508

Attn: Mr. Gil Hulsmann
Tel: 253-435-3699 x1510
Email: gil.hulsmann@abbeyroadgroup.com

Reference: Laboratory Testing – Recycled Glass
East Town Crossing Project
SE Corner of E Shaw Road & E Pioneer Way
Puyallup, Washington

Dear Mr. Hulsmann,

The gradation and proctor test results for the two recycled glass samples, one designated "clean" and the other designated "with fines", supplied by Dan Lloyd Construction are attached to this letter. The gradation tests were conducted on the samples 'as received' and again after completing the Proctor compaction tests. As can be seen in the summary of test results, Table 1 attached to this letter, the glass pierces broke down significantly due to the compaction efforts.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

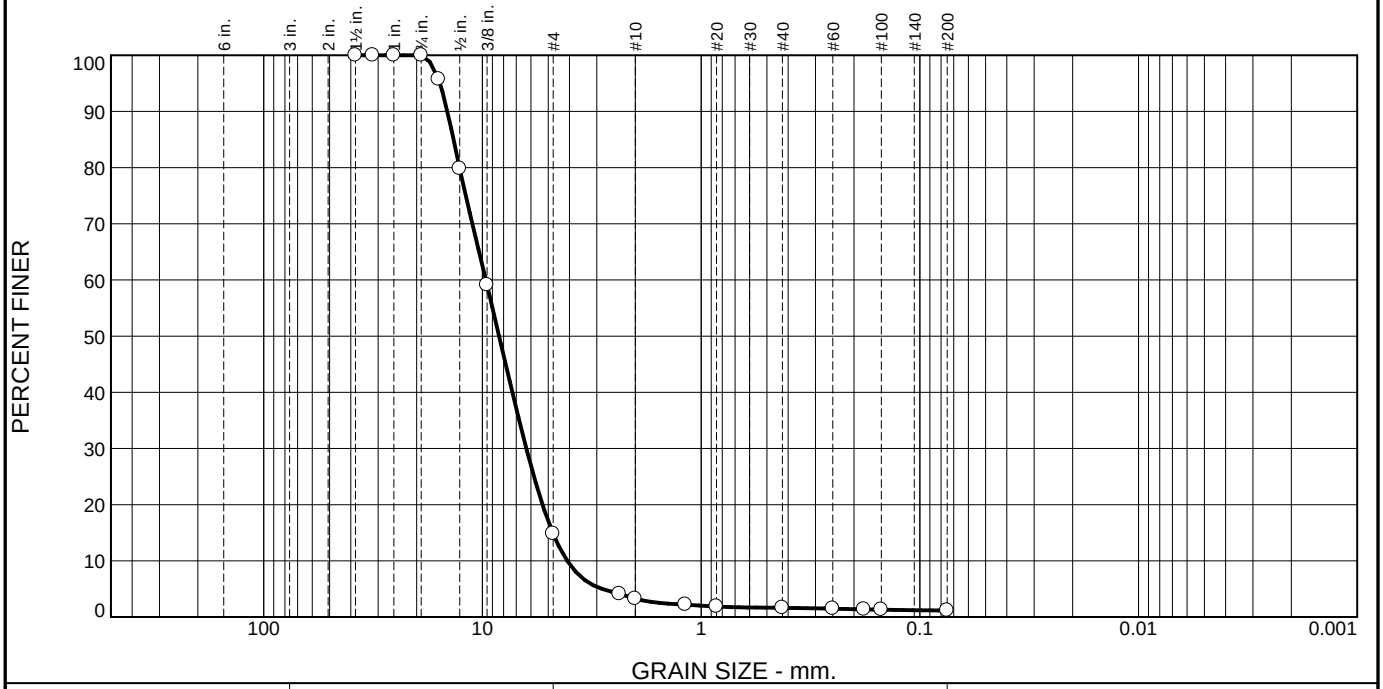
Respectfully submitted,

KRAZAN & ASSOCIATES, INC.

Theresa R. Nunan
Project Manager

Attachments: Recycled Glass Gradation and Proctor Test Results – "Clean" Sample
Recycled Glass Gradation and Proctor Test Results – "With Fines" Sample
Table 1 – Summary of Recycled Glass Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	85	12	1	1	1	

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	96		
.5	80		
.375	59		
#4	15		
#8	4		
#10	3		
#16	2		
#20	2		
#40	2		
#60	1		
#80	1		
#100	1		
#200	1.2		

* (no specification provided)

Material Description

Recycled Glass Clean - Before Compaction.
Sampled by the supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GP **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 14.4630 D_{85}= 13.5519 D_{60}= 9.6467
D_{50}= 8.3902 D_{30}= 6.2995 D_{15}= 4.7699
D_{10}= 4.0959 C_u= 2.36 C_c= 1.00

Remarks

Sample ID:21L892
Sample Date:11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21
Tested By: M.Thomas
Checked By: T.Nunan
Title: Project Manager

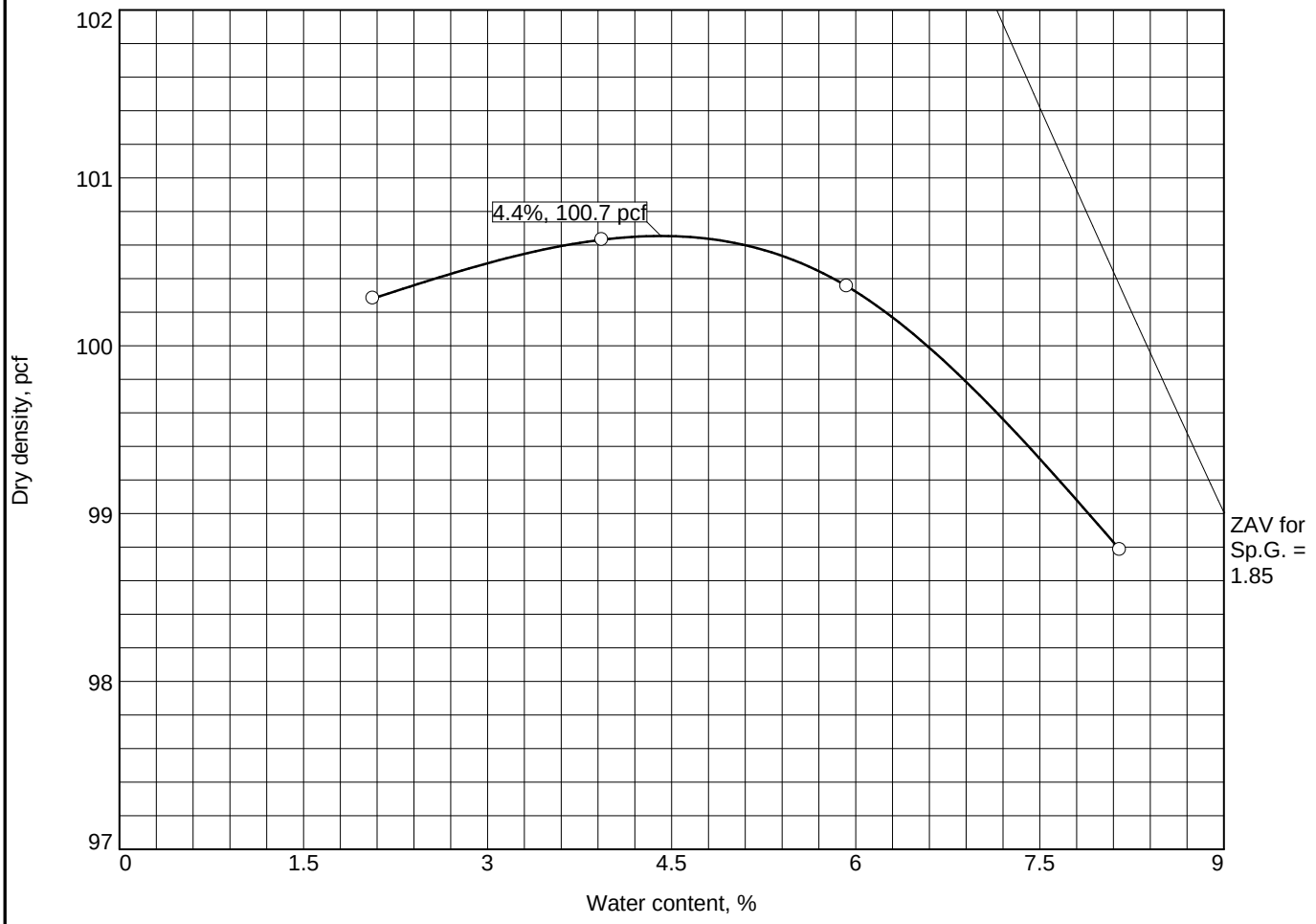
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L892

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

COMPACTION TEST REPORT



Test specification: ASTM D 1557 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	GP	A-1-a		1.85	NV	NP	0	1.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 100.7 pcf Optimum moisture = 4.4 %	Recycled Glass Clean. Sampled by the supplier.

Project No. 062-21033 **Client:** Abbey Road Group Land Development Services

Project: East Town Crossing Lab Testing - Recycled Glass

○**Source of Sample:** Dan Lloyd Construction **Sample Number:** 21L892

Remarks:

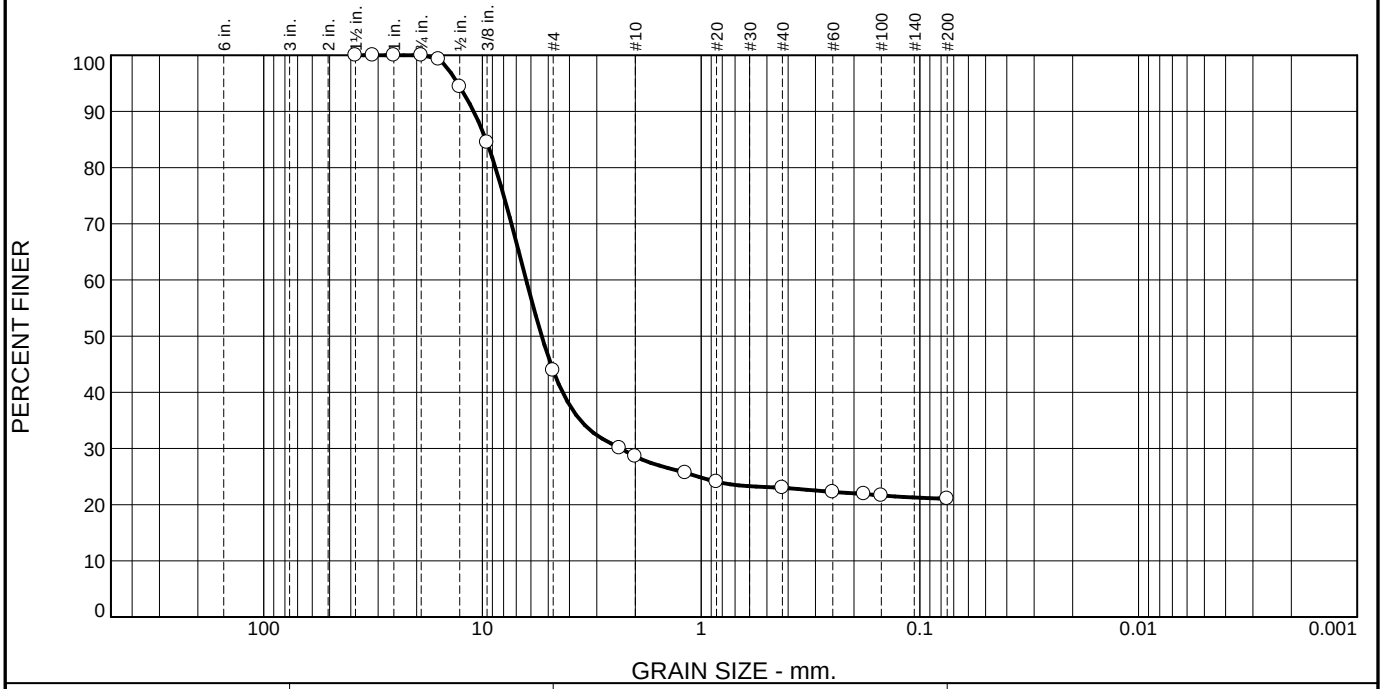
Sample ID:21L892
Sample Date:11-29-21
Void Ratio:0.14
Porosity:12%

Krazan

Figure

Tested By: M.Thomas **Checked By:** T.Nunan.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	56	15	6	2	21	

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	99		
.5	94		
.375	84		
#4	44		
#8	30		
#10	29		
#16	26		
#20	24		
#40	23		
#60	22		
#80	22		
#100	22		
#200	21		

* (no specification provided)

Material Description

Recycled Glass Clean - After Compaction
Sampled by the supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 10.9683 D_{85}= 9.6367 D_{60}= 6.3112
D_{50}= 5.3536 D_{30}= 2.3352 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:21L893
Sample Date: 11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21

Tested By: M.Thomas

Checked By: I.Teriong

Title: Project Manager

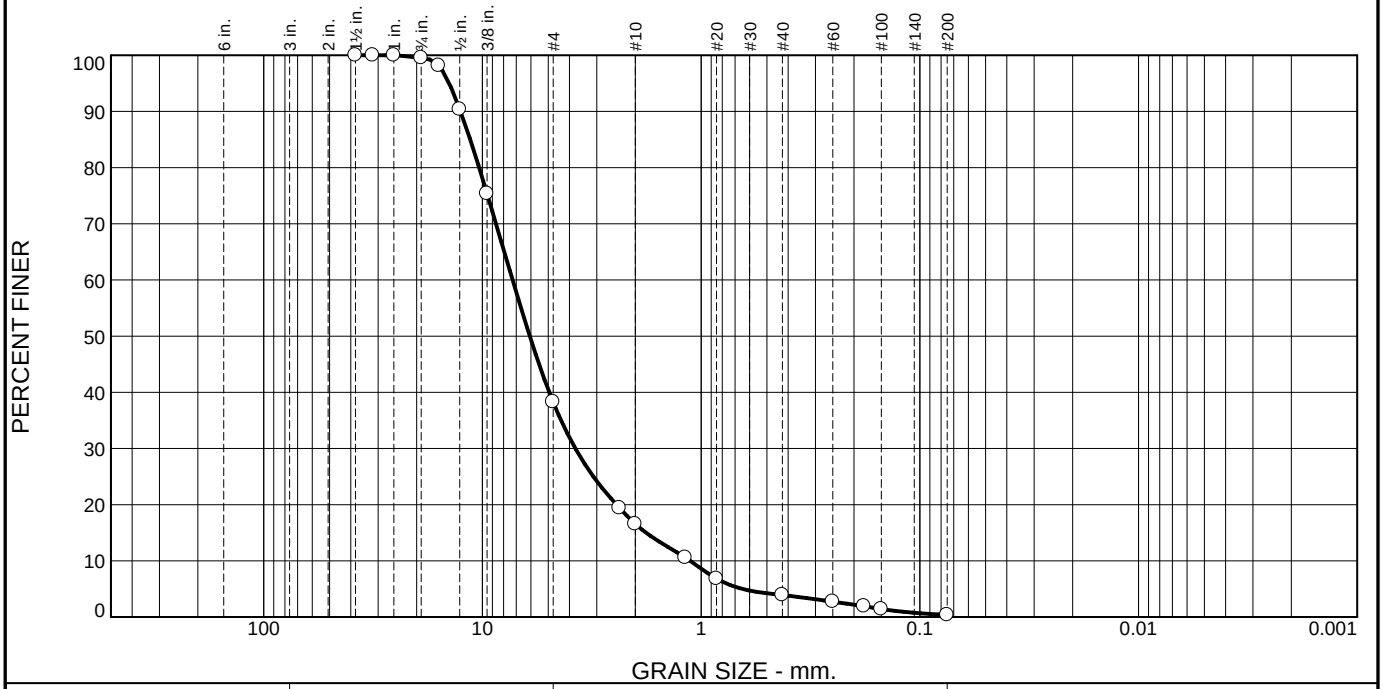
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L892

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	62	21	13	4	0	

Test Results (C-136 & c-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	98		
.5	90		
.375	75		
#4	38		
#8	19		
#10	17		
#16	11		
#20	7		
#40	4		
#60	3		
#80	2		
#100	1		
#200	0.4		

* (no specification provided)

Material Description

Recycled Glass With Fines - Before Compaction.
Sampled by the supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 12.6020 D_{85}= 11.3802 D_{60}= 7.2823
D_{50}= 6.0733 D_{30}= 3.7592 D_{15}= 1.7859
D_{10}= 1.1229 C_u= 6.49 C_c= 1.73

Remarks

Sample ID:21L893
Sample Date:11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21

Tested By: M.Thomas

Checked By: T.Nunan

Title: Project Manager

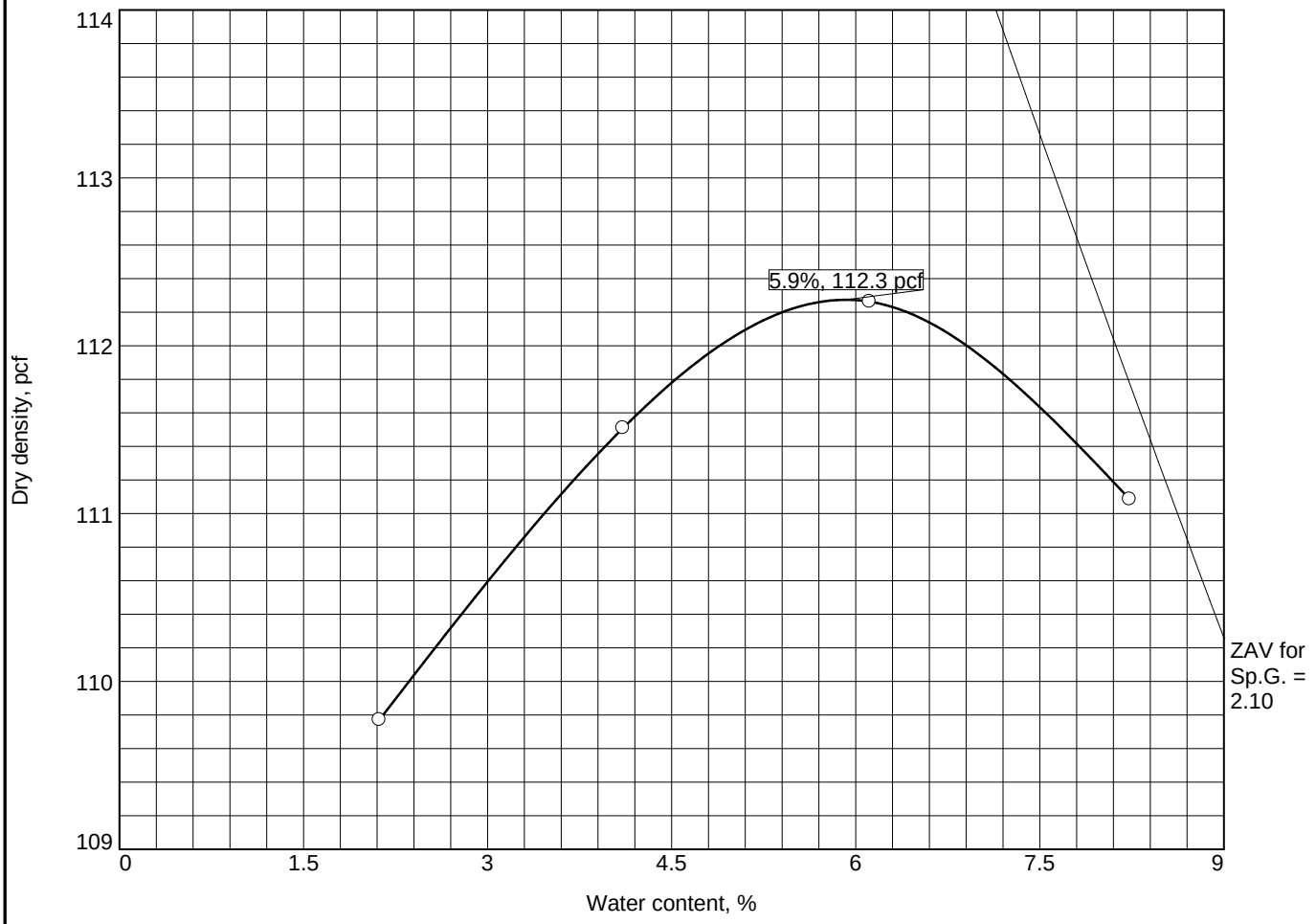
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L893

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

COMPACTION TEST REPORT



Test specification: ASTM D 1557 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	GW	A-1-a		2.1	NV	NP	0	0.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 112.3 pcf Optimum moisture = 5.9 %	Recycled Glass With Fines. Sampled by the supplier.

Project No. 062-21033 **Client:** Abbey Road Group Land Development Services

Project: East Town Crossing Lab Testing - Recycled Glass

○**Source of Sample:** Dan Lloyd Construction **Sample Number:** 21L893

Remarks:

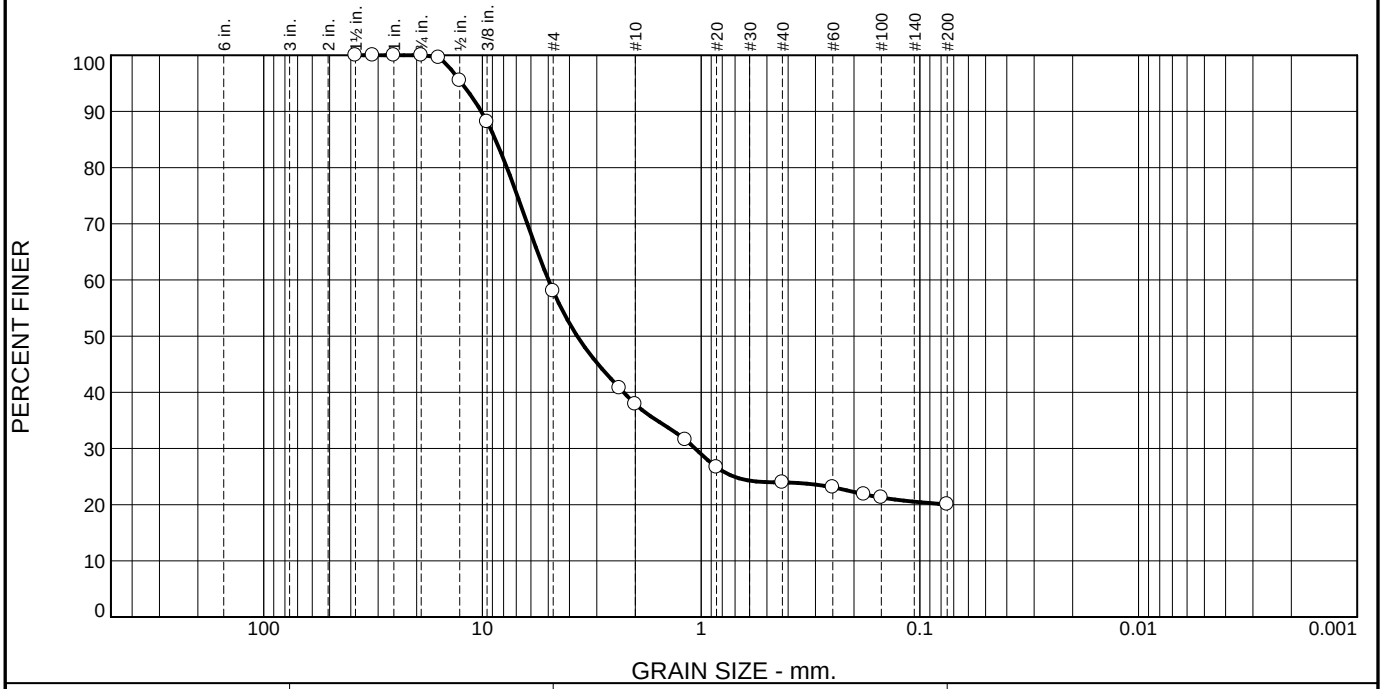
Sample ID:21L893
Sample Date:11-29-21
Void Ratio:0.16
Porosity:14%

Krazan

Figure

Tested By: M.Thomas **Checked By:** T.Nunan.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	42	20	14	4	20	

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	100		
.5	95		
.375	88		
#4	58		
#8	41		
#10	38		
#16	32		
#20	27		
#40	24		
#60	23		
#80	22		
#100	21		
#200	20		

* (no specification provided)

Material Description

Recycled Glass With Fines - After Compaction.
Sampled by the Supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 10.1195 D_{85}= 8.7171 D_{60}= 4.9887
D_{50}= 3.6862 D_{30}= 1.0651 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:21L893
Sample Date:11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21

Tested By: M.Thomas

Checked By: T.Nunan

Title: Project Manager

Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L893

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

March 19, 2021

KA Project No. 062-190007

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Gil Hulsmann
Email: Gil.Hulsmann@AbbeyRoadGroup.com
Phone: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation Addendum Letter**
East Town Crossing
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington

Dear Mr. Hulsmann,

Per your request, we have prepared this letter to provide the results of two (2) Large-Scale Pilot Infiltration Tests (PITs) we conducted at the above-referenced site. We previously prepared a geotechnical report titled "Geotechnical Engineering Investigation – East Town Crossing – Parcel Nos. 0420264053, 0420264054, 0420351066 – SE Corner of E. Shaw Road & E. Pioneer Way – Puyallup, Washington", dated April 11, 2019, as well as an addendum letter dated July 31, 2020 that addressed the nearby steep slopes.

Large-Scale PITs

Two (2) test pits, designated P-1 and P-2, were excavated near Monitoring Wells MW-1 and MW-2, respectively, on March 4, 2021 at the approximate locations indicated on the Site Plan, Figure 1, in order to conduct large-scale infiltration tests in accordance with the 2014 Stormwater Management Manual for Western Washington (SWMMWW). The infiltration test locations were selected in the field by the client and excavated using a client provided excavator and operator. The bottom of each pit was excavated 10-feet wide by 10-feet long, which met the minimum required horizontal surface area of 100 square feet (sf). Each test pit was initially excavated to a depth of 2 feet below the existing ground surface (bgs), which exposed silty sand (SM) soils at the pit bottom. Water was observed seeping from the sides of pit P-1 during excavation, and was observed ponded at the ground surface at several locations in the vicinity of pit P-1. Test pits P-1 and P-2 encountered undocumented fill to a depth of 1.8 feet and 0.5 feet bgs, respectively, followed by native brown silty sand (SM) with trace gravel and occasional sandy silt and sandy clay seams and layers to the bottom of the test pits. The soils exposed at the PIT test depth were similar to those encountered in the geotechnical borings conducted during our original exploration of the site.

The infiltration test procedure includes a pre-soak period, followed by steady-state and then falling head infiltration rate testing. Each pit was filled with water to a depth of 12 inches above the bottom of the pit for the pre-soak period. After two (2) hours of pre-soak, the water hose was turned off as even just a slight trickle caused the water level in the pit to continue to rise. Water level readings were obtained for an additional 4 hours in pit P-2 with no change in the water level, while the water level in pit P-1 increased ¾-inches which we attributed to seepage from the sides of this pit which were observed during its excavation. Since the water in pits P-1 and P-2 was not infiltrating, we left the pits open overnight, and returned to the site to record the water level. Since it had commenced to rain just prior to our leaving the site, a 5-gallon bucket was left at the location of pit P-2 to obtain an estimate of the amount of rain that fell overnight. We recorded 0.6 inches of rain in the bucket the following morning. On the morning of March 5, 2021, the water level in pit P-1 had risen another 1.2 inches, while the water level in pit P-2 rose about 0.3 inches. Figure 2 includes photos of pits P-1 and P-2 taken on March 5, 2021. The pits were not over-excavated due to the presence of water. The contractor had excavated three test pits within the northwestern corner of the site on March 4, 2021. We observed about 8 to 10 inches of water in the bottom of two of the test pits on March 5, 2021.

Evaluation of Infiltration Feasibility: One of the Site Suitability Criteria (SSC) presented in Section 3.3.7, Volume III, 2014 SWMMWW, **SSC-5 Depth to Bedrock, Water Table, or Impermeable Layer**, states that the base of all infiltration basins or trench systems shall be greater than or equal to 5 feet above the seasonal high-water mark, bedrock (or hardpan), or other low permeability layer. Based on the results of our field exploration and large-scale PITs, the soils at the site contain high silt content and are considered a very low to relatively impermeable layer. Based on the results of our general site assessment and field testing, the low permeability soils encountered at the site do not meet the requirements of Site Suitability Criteria SSC-5 and it is therefore our opinion that onsite infiltration of stormwater using basin or trench system is not considered feasible for the proposed development. **However,** consideration may be given to the use of permeable pavement and other Best Management Practices (BMPs), depending on the final site grading plan.

Limitations

This letter has been prepared for the exclusive use of the Abbey Road Group and their assigns, for the specific application to the site. The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. We emphasize that this letter is valid for this project as outlined above, and should not be used for any other site.

This letter does not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands or other biological conditions. The information presented herein is based upon professional interpretation using standard industry practices and engineering conservatism that we consider proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments.

Within the limitations of scope, schedule and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this letter was prepared. No other warranty, expressed or implied, is made.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,

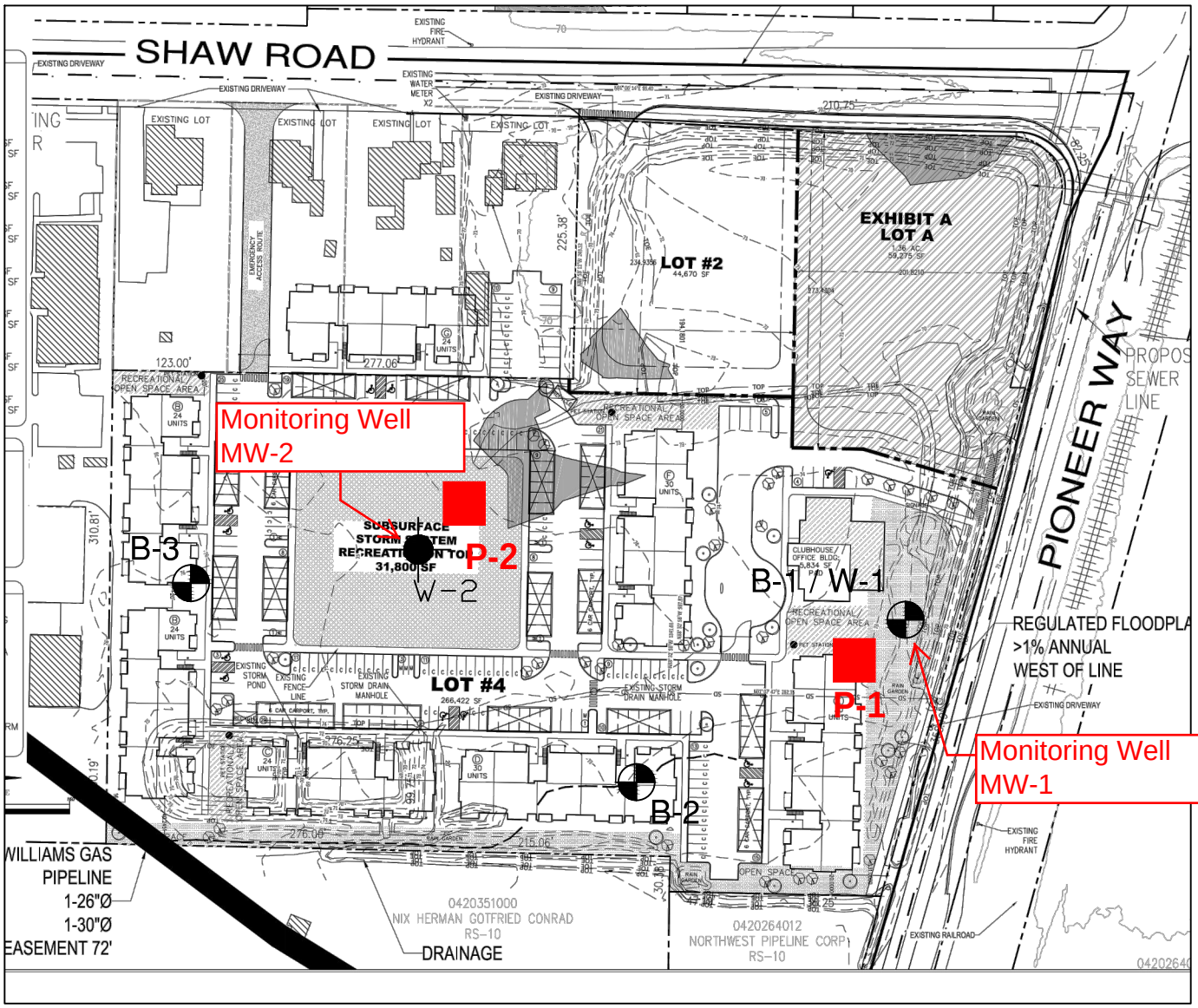
KRAZAN & ASSOCIATES, INC.

3/19/21

Theresa R. Nunan
Project Manager

Vijay Chaudhary, P.E.
Assistant Regional Engineering Manager

Attachments: Figure 1 – Site Plan
Figure 2 – Photos



LEGEND

B-1 Number and Approximate Location of Borings

W-1 Approximate Location of Monitoring Well

P-1 Approximate Location of Pilot Infiltration Test

N

Reference: Plan Sheet titled "Overall Site Plan", prepared by Abbey Road Group dated December 7, 2018.

Site Plan

East Town Crossing	Figure 1
Shaw Rd & E Pioneer Way, Puyallup, WA	
Project Number: 062-19007	Drawn By: T. Nunan Date: March 2021
Krazan & ASSOCIATES, INC.	Not to Scale

Water in Pit P-1 on March 5, 2021.

Water in Pit P-2 on March 5, 2021.

Water in Test Pit on March 5, 2021. Test pit was excavated in NE portion of site on March 4, 2021.

Figure 2 - Photos (March 5, 2021)

202 East 34th Street
Tacoma, WA 98404

Appendix E: Minimum Requirements Discussion

Minimum Requirements Discussion

East Town Crossing

City of Puyallup, Washington
Parcel No. 0420264021, 0420264053, 0420264054, 0420351066, 0420351030, 0420351029, 0420351026

8/28/2023

Project Address: 1001 Shaw Road
Puyallup, WA 98372

Property Owner:
East Town Crossing LLC
Contact: Greg Helle

Engineer: McInnis Engineering, LLC
202 E 34th Street
Tacoma, WA 98404
Contact: Kallie Maas

Minimum Requirement # 1: Preparation of Stormwater Site Plan

A stormwater site plan will be submitted with the Phase 1 Civil Plans.

Minimum Requirement # 2: Construction Stormwater Pollution Prevention

The CSWPPP and TESC plan have been prepared with the Clear, Grade and Fill submittal package.

Minimum Requirement # 3: Source Control of Pollution

The plans provided with this report will be followed in the field to reduce the potential of pollution. It is anticipated that the only source of pollution generated on site will be from the minimal disturbance of soils which will be controlled by following the provided SWPPP and TESC plan. However, construction equipment can be a big source of pollution, so it is important to adhere to the recommendations in the SWPPP and TESC plan. New construction equipment will be used, and drip pads will be placed under them when at rest. There is no anticipated pollutant post construction other than pollutants from vehicular traffic typical of a multifamily complex and commercial lots. The property owner is responsible for the control of pollutants on their property, post construction.

Minimum Requirement # 4: Preservation of Natural Drainage System and Outfalls

There is a channel to the east and one to the north, these are being preserved and enhanced. Discharge from the site is being preserved and will be directed to the natural conveyance system on East Pioneer Way. The topography of the site drains primarily from east to west. No flowing runoff has been observed or reported and no stormwater related flooding has been observed or reported.

Minimum Requirement # 5: Onsite Stormwater Management

The List Approach is being used to meet minimum requirement #5. All Lawn and Landscaped areas will utilize BMPT5.13 Post Construction Soil Quality and Depth. For roof areas, the entire list of options is infeasible on this site. Attached are listed design criteria for each BMP and how they are infeasible on this site. For the other hard surfaces, the entire list of options is also infeasible on this site. Attached are listed design criteria for each BMP and how they are infeasible on this site.

To elaborate, the site will be very developed, and there will be no opportunity for a dispersion flow path that would accommodate the stormwater produced by the development area, the geotechnical report also indicates that the groundwater table is high, and there is no ability for infiltration onsite.

Infeasibility Checklist

BMP T5.13 Post Construction Soil Quality and Depth

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-2 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.

Question Number	Question	Yes	No	NA
1	Can the soil amendments be placed on slopes less than 33%?	☒	☐	☐
2	Will installing sheet flow dispersion cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (2a-2e).	☐	☒	☐
2a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
2b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
2c	Public health and safety standards	☐		
2d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
2e	Critical Area Preservation Ordinance	☐		

Infeasibility Checklist BMP T5.30 Full Dispersion				
It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.				
Questions #1-9 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.				
Question Number	**Question**	**Yes**	**No**	**NA**
1	Can the flow spreader and dispersion areas be placed 10 feet or more from any building structure?	☐	☒	☐
2	Can the flow spreader and dispersion areas be placed 5 feet or more from any other structure or property line?	☐	☒	☐
3	Can the dispersion areas be placed 50 feet or more from the top of any slope 15% or greater?	☐	☐	☒
4	Can the dispersion areas be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the dispersion area be located outside of critical areas, critical area buffers, streams, or lakes?	☐	☐	☒
6	Can the flow spreader and dispersion area maintain setbacks from Onsite Sewage Systems per WAC 246-272A-0210?	☐	☐	☒
8	Will installing a full dispersion system cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (8a-8e).	☐	☐	☒
8a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
8b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
8c	Public health and safety standards	☐		
8d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
8e	Critical Area Preservation Ordinance	☐		
9	Can the design standards in BMP T5.30 be met?	☐	☐	☒
9a	Describe the design standard that cannot be met:			
Questions #10 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
10	Will the use of a full dispersion cause erosion or flooding problems onsite or on adjacent properties? (An answer of yes means this BMP is not feasible).	☐	☐	☒

Infeasibility Checklist

BMP T5.10A Downspout Full Infiltration

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-7 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.

Question Number	Question	Yes	No	NA
1	Can the infiltration trench or drywell be placed 10 feet or more from any building structure?	☐	☐	☒
2	Can the infiltration trench or drywell be placed 5 feet or more from any other structure or property line?	☐	☐	☒
3	Can the infiltration trench or drywell be placed 50 feet or more from the top of any slope 20% or greater?	☐	☐	☒
4	Can the infiltration trench or drywell be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the infiltration trench or drywell meet setback requirements from Onsite Sewage Systems per WAC 246-272A-0210?	☐	☐	☒
6	Will installing an infiltration trench or drywell cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (6a-6e).	☐	☐	☒
6a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
6b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
6c	Public health and safety standards	☐		
6d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
6e	Critical Area Preservation Ordinance	☐		
7	Can the design standards in BMP T5.10A be met?	☐	☐	☒
7a	Describe the design standards that cannot be met:			

Questions #8-10 relate to infeasibility criteria that are based upon subsurface characteristics and require a soils report to determine infeasibility.

8	Was the soil classified as being clay, sandy clay, clay loam, silty clay loam, sandy clay loam, or silt according to the USDA Textural Soil Triangle? (An answer of yes means this BMP is not feasible).	☐	☒	☐
9	Is the depth from proposed final grade to the seasonal high groundwater table or other impermeable layer equal to or greater than 3 feet?	☐	☒	☐
10	Is the depth from the bottom of the infiltration trench or drywell to the seasonal high groundwater table equal to or greater than 1 foot?	☐	☒	☐

Infeasibility Checklist

BMP T5.14 Rain Gardens

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-18 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries. Citation of the following do not need site-specific written recommendations from a Washington State Licensed Professional Engineer or Washington State Licensed Professional Geologist though some criteria may require professional services to determine if the infeasibility criteria apply.

Question Number	Question	Yes	No	NA
1	**Can the rain garden be placed 10 feet or more from any building structure?**	☐	☒	☐
2	Can the rain garden be placed 5 feet or more from any other structure or property line?	☐	☒	☐
3	Can the rain garden be placed 50 feet or more from the top of any slope greater than 20%?	☐	☐	☒
4	Can the rain garden be placed 50 feet or more from geologically hazardous areas?	☐	☐	☐
5	Can the rain garden be located outside of designated erosion or landslide hazard areas?	☐	☐	☒
6	Can the rain garden be located greater than 100 feet from an underground storage tank whose capacity including tank and underground connecting pipe is 1100 gallons or more?	☐	☐	☒
7	Can the rain garden be located greater than 10 feet from an underground storage tank (tank used for petroleum product, chemical, or liquid hazardous waste storage) whose capacity including tank and underground connecting pipe is 1100 gallons or less?	☐	☐	☒
8	Can the rain garden be located greater than 100 feet of a closed or active landfill?	☐	☐	☒
9	Can the rain garden be located greater than 100 feet from drinking water well or a spring used for drinking water supply?	☐	☐	☒
10	Can the rain garden be placed 10 feet or more from small on-site sewage disposal drainfields? (For large on-site sewage disposal setbacks see WAC Chapter 246-727B).	☐	☐	☒
11	Can the rain garden be located on slopes less than 8%?	☐	☐	☒
12	Is the rain garden compatible with the surrounding drainage system (e.g., project drains to an existing stormwater system whose elevation precludes proper connection to a rain garden)?	☐	☐	☒
13	For properties with known soil or groundwater contamination, can the rain garden be located greater than 100 feet from an area known to have deep soil contamination?	☐	☐	☒
14	For properties with known soil or groundwater contamination, can the rain garden be located such that infiltration will not increase or change the direction of the migration of pollutants in the groundwater? (Based upon groundwater modeling).	☐	☐	☒
15	For properties with known soil or groundwater contamination, can the rain garden be located in an area that does not have contaminated surface soils that are proposed to remain in place?	☐	☐	☒
16	For properties with known soil or groundwater contamination, can the rain garden be located in areas not prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?	☐	☐	☒

17	For rain gardens that are constructed with imported compost materials, can the rain garden be located greater than ¼ mile from a phosphorus-sensitive waterbody? (Does not apply to discharges to Wapato Lake).	☐	☐	☒
18	Will installing a rain garden cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (18a-18e).	☐	☐	☒
18a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
18b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
18c	Public health and safety standards	☐		
18d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
18e	Critical Area Preservation Ordinance	☐		
Questions #19-20 relate to infeasibility criteria that are based upon subsurface characteristics and require a soils report to determine infeasibility.				
19	Is the depth from the lowest level of the rain garden soil mix or any underlying gravel layer to the seasonal high groundwater table or other impermeable layer equal to or greater than 1 foot?	☐	☒	☐
20	Was the soil classified as having a measured native soil saturated hydraulic conductivity of 0.3 in/hour or more?	☐	☒	☐
Questions 21-28 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
21	Will the proposed rain garden location threaten the safety or reliability of preexisting underground utilities, preexisting underground storage tanks, preexisting structures, or preexisting road or parking lot surfaces? (An answer of yes means the BMP is infeasible).	☐	☐	☒
22	Will the proposed rain garden location allow for a safe overflow pathway to the City stormwater system or a private stormwater system?	☐	☐	☒
23	Are there reasonable concerns about erosion, slope failure, or downgradient flooding due to infiltration? (An answer of yes means the BMP is infeasible).	☐	☐	☒
24	Is the project located in an area whose groundwater drains into an erosion hazard or landslide hazard area? (An answer of yes means the BMP is infeasible).	☐	☐	☒
25	Will infiltrating water threaten existing below grade basements? (An answer of yes means the BMP is infeasible).	☐	☐	☒
26	Will infiltrating water threaten shoreline structures such as bulkheads? (An answer of yes means the BMP is infeasible).	☐	☐	☒
27	Is there lack of usable space onsite for rain gardens at redevelopment sites? (An answer of yes means the BMP is infeasible).	☐	☐	☒
28	For public road projects, is there insufficient space within the ROW to install a rain garden? (An answer of yes means this BMP is infeasible).	☐	☐	☒

Infeasibility Checklist

BMP T7.30 Bioretention

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach

Questions #1-18 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries. Citation of the following do not need site-specific written recommendations from a Washington State Licensed Professional Engineer or Washington State Licensed Professional Geologist though some criteria may require professional services to determine if the infeasibility criteria apply.

Question Number	Question	Yes	No	NA
1	**Can the bioretention facility be placed 10 feet or more from any building structure?**	☐	☒	☐
2	Can the bioretention facility be placed 5 feet or more from any other structure or property line?	☐	☒	☐
3	Can the bioretention facility be placed 50 feet or more from the top of any slope greater than 20%?	☐	☐	☒
4	Can the bioretention facility be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the bioretention facility be located outside of designated erosion or landslide hazard areas?	☐	☐	☒
6	Can the bioretention facility be located greater than 100 feet from an underground storage tank whose capacity including tank and underground connecting pipe is 1100 gallons or more?	☐	☐	☒
7	Can the bioretention facility be located greater than 10 feet from an underground storage tank (tank used for petroleum product, chemical, or liquid hazardous waste storage) whose capacity including tank and underground connecting pipe is 1100 gallons or less?	☐	☐	☒
8	Can the bioretention facility be located greater than 100 feet of a closed or active landfill?	☐	☐	☒
9	Can the bioretention facility be located greater than 100 feet from drinking water well or a spring used for drinking water supply?	☐	☐	☒
10	Can the bioretention facility be placed 10 feet or more from small on-site sewage disposal drainfields? (For large on-site sewage disposal setbacks see WAC Chapter 246-727B).	☐	☐	☒
11	Can the bioretention facility be located on slopes less than 8%?	☐	☐	☒
12	Is the bioretention facility compatible with the surrounding drainage system (e.g., project drains to an existing stormwater system whose elevation precludes proper connection to the bioretention facility)?	☐	☐	☒
13	For properties with known soil or groundwater contamination, can the bioretention facility be located greater than 100 feet from an area known to have deep soil contamination?	☐	☐	☒
14	For properties with known soil or groundwater contamination, can the bioretention facility be located such that infiltration will not increase or change the direction of the migration of pollutants in the groundwater? (Based upon groundwater modeling).	☐	☐	☒
15	For properties with known soil or groundwater contamination, can the bioretention facility be located in an area that does not have contaminated surface soils that are proposed to remain in place?	☐	☐	☒
16	For properties with known soil or groundwater contamination, can the bioretention facility be located in areas not prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal	☐	☐	☒

	Superfund Law, or an environmental covenant under Chapter 64.70 RCW?			
17	For bioretention facilities that are constructed with imported compost materials, can the bioretention facility be located greater than ¼ mile from a phosphorus-sensitive waterbody? (Does not apply to discharges to Wapato Lake).	☐	☐	☒
18	Will installing a bioretention facility cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (18a-18e).	☐	☐	☒
18a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
18b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
18c	Public health and safety standards	☐		
18d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
18e	Critical Area Preservation Ordinance	☐		
Questions #19-21 relate to infeasibility criteria that are based upon subsurface characteristics and require a soils report to determine infeasibility.				
19	Is the depth from the lowest level of the bioretention soil mix or any underlying gravel layer to the seasonal high groundwater table or other impermeable layer equal to or greater than 1 foot? This applies only if the contributing area to the bioretention facility has less than 5,000 square feet of pollution-generating impervious surface, and less than 10,000 square feet of impervious surface, and less than ¾ acre pervious surface.	☐	☒	☐
20	Is the depth from the lowest level of the bioretention soil mix or any underlying gravel layer to the seasonal high groundwater table or other impermeable layer equal to or greater than 3 feet? This applies only if the contributing area to the bioretention facility has: 5,000 square feet or greater of pollution-generating impervious surface, or 10,000 square feet or greater of impervious surface, or more ¾ acre pervious surface AND the bioretention facility cannot be broken down into amounts smaller than those listed above.	☐	☒	☐
21	Was the soil classified as having a measured native soil saturated hydraulic conductivity of 0.3 in/hour or more?	☐	☒	☐
Questions 22-29 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
22	Will the proposed bioretention facility location threaten the safety or reliability of preexisting underground utilities, preexisting underground storage tanks, preexisting structures, or preexisting road or parking lot surfaces? (An answer of yes means the BMP is infeasible).	☐	☐	☒
23	Will the proposed bioretention facility location allow for a safe overflow pathway to the City stormwater system or a private stormwater system?	☐	☐	☒
24	Are there reasonable concerns about erosion, slope failure, or downgradient flooding due to infiltration? (An answer of yes means the BMP is infeasible).	☐	☐	☒
25	Is the project located in an area whose groundwater drains into an erosion hazard or landslide hazard area? (An answer of yes means the BMP is infeasible).	☐	☐	☒
26	Will infiltrating water threaten existing below grade basements? (An answer of yes means the BMP is infeasible).	☐	☐	☒

27	Will infiltrating water threaten shoreline structures such as bulkheads? (An answer of yes means the BMP is infeasible).	☐	☐	☒
28	Is there lack of usable space onsite for bioretention facilities at redevelopment sites? (An answer of yes means the BMP is infeasible).	☐	☐	☒
29	For public road projects, is there insufficient space within the ROW to install a bioretention facility? (An answer of yes means this BMP is infeasible).	☐	☐	☒

Infeasibility Checklist

BMP T5.10B Downspout Dispersion

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-10 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.

Question Number	Question	Yes	No	NA
1	Can the dispersion trench or splashblocks be placed 10 feet or more from any building structure?	☐	☒	☐
2	Can the dispersion trench or splashblocks be placed 5 feet or more from any other structure or property line?	☐	☒	☐
3	Can the dispersion trench or splashblocks be placed 50 feet or more from the top of any slope 15% or greater?	☐	☐	☒
4	Can the dispersion trench or splashblocks be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the dispersion trench or splashblock maintain setbacks from Onsite Sewage Systems per WAC 246-272A-0210?	☐	☐	☒
6	Is it possible to maintain or construct a vegetated flowpath of at least 25 feet from the outlet of a dispersion trench and any property line, structure, stream, wetland, other infiltration or dispersion system, or impervious surface?	☐	☒	☐
7	Is it possible to maintain or construct a vegetated flowpath of at least 50 feet from the outlet of a dispersion trench and any slope greater than 15%?	☐	☐	☒
8	Is it possible to maintain or construct a vegetated flowpath of at least 50 feet from the outlet of splashblock and any property line, structure, slope over 15%, stream, wetland, other infiltration or dispersion system, or impervious surface?	☐	☐	☒
9	Will installing a dispersion trench or splashblocks cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (9a-9e).	☐	☐	☒
9a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
9b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
9c	Public health and safety standards	☐		
9d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
9e	Critical Area Preservation Ordinance	☐		
10	Can the design standards in BMP T5.10B be met?	☐	☐	☒
10a	Describe the design standard that cannot be met:			
Questions #11 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
11	Will the use of a dispersion trench or splashblocks cause erosion or flooding problems onsite or on adjacent properties? (An answer of yes means this BMP is not feasible).	☐	☐	☒

Infeasibility Checklist

BMP T5.10C: Perforated Stub-out Connections

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-7 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.

Question Number	Question	Yes	No	NA
1	Can the perforated stub-out connection be placed 10 feet or more from any building structure?	☐	☒	☐
2	Can the perforated stub-out connection be placed 5 feet or more from any other structure or property line?	☐	☐	☒
3	Can the perforated stub-out connection be placed 50 feet or more from the top of any slope 20% or greater?	☐	☐	☒
4	Can the perforated stub-out connection be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the perforated stub-out connection meet setback requirements from Onsite Sewage Systems per WAC 246-272A-0210?	☐	☐	☒
6	Will installing a perforated stub-out connection cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (6a-6e).	☐	☐	☒
6a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
6b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
6c	Public health and safety standards	☐		
6d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
6e	Critical Area Preservation Ordinance	☐		
7	Can the design standards in BMP T5.10C be met?	☐	☐	☒
7a	Describe the design standard that cannot be met:			

Questions #8 relates to infeasibility criteria that are based upon subsurface characteristics and require a soils report to determine infeasibility.

8	Is the depth from the bottom of the perforated stub-out connection to the seasonal high groundwater table equal to or greater than 1 foot?	☐	☒	☐

Infeasibility Checklist

BMP T5.15 Permeable Pavement

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-24 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries. Citation of the following do not need site-specific written recommendations from a Washington State Licensed Professional Engineer or Washington State Licensed Professional Geologist though some criteria may require professional services to determine if the infeasibility criteria apply.

Question Number	Question	Yes	No	NA
1	**Can the permeable pavement be placed 10 feet or more from any building structure?**	☐	☐	☒
2	Can the permeable pavement be placed 5 feet or more from any other structure or property line?	☐	☐	☒
3	Can the permeable pavement be placed 50 feet or more from the top of any slope greater than 20%?	☐	☐	☒
4	Can the permeable pavement be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the permeable pavement be located outside of designated erosion or landslide hazard areas?	☐	☐	☒
7	Can the permeable pavement be located greater than 10 feet from an underground storage tank (tank used for petroleum product, chemical, or liquid hazardous waste storage) whose capacity including tank and underground connecting pipe is 1100 gallons or less?	☐	☐	☐
8	Can the permeable pavement be located greater than 100 feet of a closed or active landfill?	☐	☐	☒
9	Can the permeable pavement be located greater than 100 feet from drinking water well or a spring used for drinking water supply if the permeable pavement is (or has run-on from) a pollution-generating hard surface?	☐	☐	☒
10	Can the permeable pavement be placed 10 feet or more from small on-site sewage disposal drainfields? (For large on-site sewage disposal setbacks see WAC Chapter 246-727B).	☐	☐	☒
11	Can the permeable pavement be constructed such that the subgrade is less than 6%?	☐	☐	☒
12	Can the permeable pavement be constructed such that the wearing course is less than 6% (after reasonable attempts have been made to design the grade)?	☐	☐	☒
13	Is the location for permeable pavement a multi-level parking garage, above a culvert, or a bridge? An answer of yes means the BMP is not feasible.	☐	☐	☒
14	Does the road receive more than very low traffic volumes? (Roads with a projected average daily traffic volume of 400 vehicles or less). This infeasibility criterion cannot be used for sidewalks or non-traffic bearing surfaces. An answer of yes means the BMP is not feasible.	☐	☐	☒
15	Does the road receive more than very low truck traffic? (Roads not subject to through truck traffic but may receive up to weekly use by utility trucks, daily school bus use, and multiple daily use by pick-up trucks, mail/parcel delivery trucks, and maintenance vehicles.). This infeasibility criterion cannot be used for sidewalks or non-traffic bearing surfaces. An answer of yes means the BMP is not feasible.	☐	☐	☒

16	Does the area typically generate high concentrations of oil due to high traffic turnover or frequent transfer of oil? (See SWMM for additional guidance.) An answer of yes means the BMP is not feasible.	☐	☐	☒
17	Can the permeable pavement be located outside of areas with industrial activity as identified in 40 CFR 122.26(b)14?	☐	☐	☒
18	Can permeable pavement be located outside of areas where the risk of concentrated pollutant spills is likely such as gas stations, truck stops, and industrial chemical storage areas?	☐	☐	☒
19	Can permeable pavement be located outside of areas likely to have long-term excessive sediment deposition after construction?	☐	☐	☒
20	For properties with known soil or groundwater contamination, can the permeable pavement be located greater than 100 feet from an area known to have deep soil contamination?	☐	☐	☒
21	For properties with known soil or groundwater contamination, can the permeable pavement be located such that infiltration will not increase or change the direction of the migration of pollutants in the groundwater? (Based upon groundwater modeling).	☐	☐	☒
22	For properties with known soil or groundwater contamination, can the permeable pavement be located in an area that does not have contaminated surface soils that are proposed to remain in place?	☐	☐	☒
23	For properties with known soil or groundwater contamination, can the permeable pavement be located in areas not prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?	☐	☐	☒
24	Will installing permeable pavement cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (24a-24e).	☐	☐	☒
24a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
24b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
24c	Public health and safety standards	☐		
24d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
24e	Critical Area Preservation Ordinance	☐		
Questions #25-28 relate to infeasibility criteria that are based upon subsurface characteristics and require a soils report to determine infeasibility.				
25	Is the depth from the lowest layer designed as part of the permeable pavement section to the seasonal high groundwater elevation, bedrock, or other impermeable layer equal to or greater than 1 foot?	☐	☐	☒
26	For pollution generating pervious pavement surfaces, can the soil suitability criteria for treatment be met? (See SWMM – BMP T5.15)	☐	☐	☒
27	Was the soil classified as having a measured native soil saturated hydraulic conductivity of 0.3 in/hour or more?	☐	☒	☐
28	Is the existing impervious surface that will be replaced non-polluting generating and located over an outwash soil with a saturated hydraulic conductivity of 4 inches/hour or greater?	☐	☐	☒
Questions 29-40 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
29	Will the proposed permeable pavement location threaten the safety or reliability of preexisting underground utilities, preexisting underground	☐	☐	☒

	storage tanks, preexisting structures, or preexisting road or parking lot surfaces? (An answer of yes means the BMP is infeasible).			
30	Will infiltrating and ponded water compromise existing adjacent impervious pavements? (An answer of yes means the BMP is infeasible).	☐	☐	☐
31	Are there reasonable concerns about erosion, slope failure, or downgradient flooding due to infiltration? (An answer of yes means the BMP is infeasible).	☐	☐	☒
32	Can the permeable pavement be located outside area whose groundwater drains into an erosion hazard or landslide hazard area?	☐	☐	☒
33	Will infiltrating water threaten existing below grade basements? (An answer of yes means the BMP is infeasible).	☐	☐	☒
34	Will infiltrating water threaten shoreline structures such as bulkheads? (An answer of yes means the BMP is infeasible).	☐	☐	☒
35	Can permeable pavement be located away from the bottom of steep, erosion prone areas that are likely to erode sediment?	☐	☐	☒
36	Can permeable pavement be located away from fill soils that can become unstable when saturated?	☐	☐	☒
37	Will permeable pavement construction on steep slopes cause erosion and structural failure? (An answer of yes means the BMP is infeasible).	☐	☐	☒
38	Will permeable pavement construction on steep slopes cause runoff velocities that preclude adequate infiltration at the pavement surfaces? (An answer of yes means the BMP is infeasible).	☐	☐	☒
39	Can permeable pavement provide sufficient strength to support the anticipated loads?	☐	☒	☐
40	Are underlying soils suitable for supporting traffic loads when saturated?	☐	☒	☐

Infeasibility of Permeable Pavement

According to the Department of Ecology 2019 Stormwater Management Manual for Western Washington 2019, Volume V, BMP T5.15 (Pages 748 – 751), the following criteria are considered to render permeable pavement infeasible. For brevity, we include below only those criteria that apply to our current situation. (Citations from the SWMMWW are in ***bold italics*** below)

"Citation of any of the following infeasibility criteria must be based on an evaluation of site-specific conditions and a written recommendation from an appropriate licensed professional (e.g, engineer, geologist, hydrogeologist)"

Infeasibility Criteria based on lack of infiltration in native soils (Page 750)

"Where appropriate field testing indicates soils have a measured (a.k.a., initial) native soil saturated hydraulic conductivity (Ksat) less than 0.3 inches per hour. See V-5.4 Determining the Design Infiltration Rate of the Native Soils. (Note: In these instances, unless other infeasibility restrictions apply, roads and parking lots may be built with an underdrain, preferably elevated within the base course, if Flow Control benefits are desired.)"

The infiltration rate of the native soils is 0 in/hr. as shown in the reports provided by Krazan Associates and as supported by the included letter from Migizi Group. Note that the allowance for an underdrain system does not apply in this case as other infeasibility restrictions apply.

Infeasibility Criteria based on inability of soils to support traffic when saturated (Page 750)

"Where underlying soils are unsuitable for supporting traffic loads when saturated. Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads."

The original testing by Krazan Associates showed that the underlying soils are unsuitable for supporting traffic loads. In fact, the original geotechnical engineering report dated April 11, 2019, stated *"The subgrade strength and performance characteristics of a silty subgrade material may be dramatically reduced if this material becomes wet."***.** We have also obtained a letter, attached, from the new geotechnical engineer on the project, Migizi Group, indicating that these soils will not be able to support traffic loads when saturated.

Two sites nearby (Pioneer Crossing and portions of Shaw Road south of the subject site), which have employed pervious pavement, are failing only a few years after those pavements were installed. These nearby examples provide empirical proof that the underlying soils are unsuitable for supporting the experienced traffic load when saturated.

According to the project requirements applied to this project by the City of Puyallup Fire Department, every part of the paved surface must be able to support their fire truck outriggers. According to the attached letter from Jim Brigham of Migizi Group, the site is

incapable of supporting standard truck traffic when saturated. It cannot, then, support an HS-25 load when saturated.

Infeasibility Criteria based on high traffic volumes (Page 750)

"Roads that receive more than very low traffic volumes. Roads with a projected average daily traffic volume of 400 vehicles or less are very low volume roads (AASHTO, 2001), (USDOT, 2013). Note: This infeasibility criterion does not extend to sidewalks and other non-traffic bearing surfaces."

According to the work done by Heath and Associates and presented in their traffic report dated September 21, 2022, the roads within East Town Crossing will experience approximately 1,680 daily trips (weekday), over 4 times the allowed 400 trips.

Infeasibility Criteria based on high truck traffic volumes (Page 750)

"***Areas having more than very low truck traffic. Areas with very low truck traffic volumes are roads and other areas not subject to through truck traffic but may receive up to weekly use by utility trucks (e.g., garbage, recycling), daily school bus use, and multiple daily use by pick-up trucks, mail/parcel delivery trucks, and maintenance vehicles. Note: This infeasibility criterion does not extend to sidewalks and other non-traffic bearing surfaces."***

According to discussions with Murrey Disposal, who services the City of Puyallup, this site will have 2 trucks/week for the residential garbage, 2 separate trucks/week for residential recycling, and 1-2 separate trucks/week for the commercial disposal. 5-6 trucks will visit the site weekly, significantly more than the 1 truck/week allowed.

Infeasibility Checklist

BMP T5.12: Sheet Flow Dispersion

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-9 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.

Question Number	Question	Yes	No	NA
1	Can the sheet flow dispersions system be placed 10 feet or more from any building structure?	☐	☒	☐
2	Can the sheet flow dispersion system be placed 5 feet or more from any other structure or property line?	☐	☒	☐
3	Can the sheet flow dispersion system be placed 50 feet or more from the top of any slope 15% or greater?	☐	☐	☒
4	Can the sheet flow dispersion system be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the sheet flow dispersion system maintain setbacks from Onsite Sewage Systems per WAC 246-272A-0210?	☐	☐	☒
6	Is it possible to provide a vegetated flowpath width of 10 feet or greater for up to 20 feet of width of paved or impervious surface?	☐	☒	☐
7	For paved or impervious surfaces widths 20 feet or greater, is it possible to provide a vegetated flowpath width of 20 feet or greater (additional 10 feet of width must be added for each increment of 20 feet or more in width)?	☐	☒	☐
8	Will installing sheet flow dispersion cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (8a-8e).	☐	☐	☒
8a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
8b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
8c	Public health and safety standards	☐		
8d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
8e	Critical Area Preservation Ordinance	☐		
9	Can the design standards in BMP T5.12 be met?	☐	☐	☒
9a	Describe the design standard that cannot be met:			
Questions #10 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
10	Will the use of sheet flow dispersion cause erosion or flooding problems onsite or an adjacent properties? (An answer of yes means this BMP is not feasible).	☐	☐	☒

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Infeasibility Checklist

BMP T5.11: Concentrated Flow Dispersion

It is not necessary to answer all questions when determining if a BMP is feasible for Minimum Requirement #5 – The List Approach. Unless otherwise noted, a single answer of No means the BMP is considered infeasible for meeting Minimum Requirement #5 – The List Approach.

Questions #1-8 relate to infeasibility criteria that are based on conditions such as topography and distances to predetermined boundaries and certain design criteria.

Question Number	Question	Yes	No	NA
1	Can the concentrated flow dispersion system be placed 10 feet or more from any building structure?	☐	☒	☐
2	Can the concentrated flow dispersion system be placed 5 feet or more from any other structure or property line?	☐	☒	☐
3	Can the concentrated flow dispersion system be placed 50 feet or more from the top of any slope 15% or greater?	☐	☐	☒
4	Can the concentrated flow dispersion system be placed 50 feet or more from geologically hazardous areas?	☐	☐	☒
5	Can the concentrated flow dispersion system maintain setbacks from Onsite Sewage Systems per WAC 246-272A-0210?	☐	☐	☒
6	Is it possible to maintain or construct a vegetated flowpath of at least 25 feet from the discharge location and any property line, structure, slope greater than 15%, surface water, or other hard surface?	☐	☒	☐
7	Will installing concentrated flow dispersion cause conflicts with any of the following? (An answer of yes means this BMP is infeasible.) Place a checkmark next to the applicable item (7a-7e).	☐	☐	☒
7a	Requirements of the Historic Preservation Laws and Archeology Laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, or Americans with Disability Act	☐		
7b	Special zoning district design criteria adopted and being implemented through any City of Puyallup planning efforts	☐		
7c	Public health and safety standards	☐		
7d	Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way	☐		
7e	Critical Area Preservation Ordinance	☐		
8	Can the design standards in BMP T5.11 be met?	☐	☐	☒
8a	Describe the design standard that cannot be met:			
Questions #9 require evaluation of site specific conditions and a written recommendation from an appropriate Washington State Licensed Professional (e.g., Professional Engineer, Professional Geologist, Professional Hydrogeologist).				
9	Will the use of concentrated flow dispersion cause erosion or flooding problems onsite or an adjacent properties? (An answer of yes means this BMP is not feasible).	☐	☐	☐

Minimum Requirement # 6: Stormwater Treatment

The entire site will be treated for water quality via Contech Modular Wetlands systems. A stormwater biofiltration system will be located on the commercial site in the northwest corner of the site and will intercept the discharge pipe that discharges water from the flow control RTanks on the site. The water quality system was designed by Contech to meet Ecology requirements and is detailed on the plans submitted with this report. This water quality system is sized to the 2-year release flow rate.

Minimum Requirement # 7: Flow Control

The stormwater system designed for the site includes 3 large RTank systems, one serving the commercial site and a two-RTank system joined by a 36" detention pipe serving the remainder of the site.

The RTank serving the commercial site in the northwest portion of the site is designed to include an active detention area that is 229' Long x 63' wide x 3.5' deep. The RTanks are designed for outrigger loading.

The RTank system serving the remainder of the site is comprised of 2 RTanks joined by a 36" diameter detention pipe. The RTank on the west side of the site is 200' long x 74' wide x 5.5' deep, and the last RTank is 189' x 63' x 5.5' deep. Again, the RTanks are rated for outriggers.

While the specific structural details for the RTanks will be provided in the final design, ACF was consulted for the layout of the RTanks, so the sizing, depth, and volume have been fully vetted to work with the site and the depth available without being impacted by groundwater. The RTanks have been designed as slightly larger than the size given in WWHM to account for sediment build up that could result from infrequent maintenance.

Minimum Requirement # 8: Wetlands Protection

There are no identified offsite wetlands to the east of the project site as identified by Soundview Consultants in their Technical Memorandum dated April 13, 2023.

Minimum Requirement # 9: Operations and Maintenance

Sediment control structures need to be cleaned at least once every 3 months in the winter and fall months. Catch basin shall be checked per maintenance recommendations and after major storm events. An operations and maintenance manual will be included in the Phase 1 submittal.

202 East 34th Street
Tacoma, WA 98404

Appendix F: Best Management Practices

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202 East 34th Street
Tacoma, WA 98404

II-3.2 Construction Source Control BMPs

C102 // Buffer Zones

Purpose

Creation of an undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and stormwater runoff velocities.

Conditions of Use

Buffer zones are used along streams, wetlands and other bodies of water that need protection from erosion and sedimentation. Contractors can use vegetative buffer zone BMPs to protect natural swales and they can incorporate them into the natural landscaping of an area.

Do not use critical-areas buffer zones as sediment treatment areas. These areas shall remain completely undisturbed. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

The types of buffer zones can change the level of protection required as shown below:
Designated Critical Area Buffers - buffers that protect Critical Areas, as defined by the Washington State Growth Management Act, and are established and managed by the local permitting authority. These should not be disturbed and must protected with sediment control BMPs to prevent impacts. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

Vegetative Buffer Zones - areas that may be identified in undisturbed vegetation areas or managed vegetation areas that are outside any Designated Critical Area Buffer. They may be utilized to provide an additional sediment control area and/or reduce runoff velocities. If being used for preservation of natural vegetation, they should be arranged in clumps or strips. They can be used to protect natural swales and incorporated into the natural landscaping area.

Design and Installation Specifications

- Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Mark clearing limits and keep all equipment and construction debris out of the natural areas and buffer zones. Steel construction fencing is the most effective method to protect sensitive areas and buffers. Alternatively, wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective.
- Keep all excavations outside the dripline of trees and shrubs.

- Do not push debris or extra soil into the buffer zone area because it will cause damage by burying and smothering vegetation.
- Vegetative buffer zones for streams, lakes or other waterways shall be established by the local permitting authority or other state or federal permits or approvals.

Maintenance Standards
Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed. Replace all damaged flagging immediately. Remove all materials located in the buffer area that may impede the ability of the vegetation to act as a filter.

C103 // High Visibility Fence

Purpose
High-visibility fencing is intended to:

- Restrict clearing to approved limits.
- Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
- Limit construction traffic to designated construction entrances, exits, or internal roads.
- Protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use
To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications
High-visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high-visibility orange. The fence tensile strength shall be 360 lbs/ft using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233: Silt Fence to act as high-visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications.

Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards
If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

C105 // Stabilized Construction Entrance / Exit

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Purpose

Stabilized construction accesses are established to reduce the amount of sediment transported onto paved roads outside the project site by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for project sites.

Conditions of Use

Construction accesses shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential subdivision construction sites, provide a stabilized construction access for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size and configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized accesses not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure II-3.1: Stabilized Construction Access for details. Note: the 100' minimum length of the access shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100').

Construct stabilized construction accesses with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, cement, or calcium chloride for construction access stabilization because these products raise pH levels in stormwater and concrete discharge to waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the standards listed in Table II-3.2: Stabilized Construction Access Geotextile Standards.

Table II-3.2: Stabilized Construction Access Geotextile Standards

Geotextile Property	Required Value
Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will be paved; this can be used as a stabilized access. Also consider the installation of excess concrete as a stabilized access. During large concrete pours, excess concrete is often available for this purpose.
- Fencing (see BMP C103: High-Visibility Fence) shall be installed as necessary to restrict traffic to the construction access.
- Whenever possible, the access shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.

- Construction accesses should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction access must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Alternative Material Specification

WSDOT has raised safety concerns about the Quarry Spall rock specified above. WSDOT observes that the 4-inch to 8-inch rock sizes can become trapped between Dually truck tires, and then released off-site at highway speeds. WSDOT has chosen to use a modified specification for the rock while continuously verifying that the Stabilized Construction Access remains effective. To remain effective, the BMP must prevent sediment from migrating off site. To date, there has been no performance testing to verify operation of this new specification. Jurisdictions may use the alternative specification, but must perform increased off-site inspection if they use, or allow others to use, it.

Stabilized Construction Accesses may use material that meets the requirements of WSDOT's *Standard Specifications for Road, Bridge, and Municipal Construction* Section 9-03.9(1) (WSDOT, 2016) for ballast except for the following special requirements.
The grading and quality requirements are listed in Table II-3.3: Stabilized Construction Access Alternative Material Requirements.

Table II-3.3: Stabilized Construction Access Alternative Material Requirements

Sieve Size	Percent Passing
2½″	99-100
2″	65-100
¾″	40-80
No. 4	5 max.
No. 100	0-2
% Fracture	75 min.

- All percentages are by weight.
- The sand equivalent value and dust ratio requirements do not apply.
- The fracture requirement shall be at least one fractured face and will apply the combined aggregate retained on the No. 4 sieve in accordance with FOP for AASHTO T 335.

Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- If the access is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the access, or the installation of BMP C106: Wheel Wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a

small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction access(es), BMP C103: High-Visibility Fence shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

C106 // Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by washing dirt from the wheels of motor vehicles prior to the motor vehicles leaving the construction site.

Conditions of Use

- Use a wheel wash when BMP C105: Stabilized Construction Access is not preventing sediment from being tracked off site.
- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.
- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.
- Wheel wash wastewater is not stormwater. It is commonly called process water, and must be discharged to a separate on-site treatment system that prevents discharge to waters of the State, or to the sanitary sewer with local sewer district approval.
- Wheel washes may use closed-loop recirculation systems to conserve water use.
- Wheel wash wastewater shall not include wastewater from concrete washout areas.
- When practical, the wheel wash should be placed in sequence with BMP C105: Stabilized Construction Access. Locate the wheel wash such that vehicles exiting the wheel wash will enter directly onto BMP C105: Stabilized Construction Access. In order to achieve this, BMP C105: Stabilized Construction Access may need to be extended beyond the standard installation to meet the exit of the wheel wash.

Design and Installation Specifications

Suggested details are shown in Figure II-3.2: Wheel Wash. The Local Permitting Authority may allow other designs. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.

Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

Midpoint spray nozzles are only needed in extremely muddy conditions.

Wheel wash systems should be designed with a small grade change, 6- to 12-inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system.

Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.

Maintenance Standards
The wheel wash should start out each day with fresh water.
The wheel wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wheel wash water will need to be changed more often.

C107 // Construction Road / Parking Area Stabilization

Purpose
Stabilizing roads, parking areas, and other on-site vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or stormwater runoff.

Conditions of Use
Roads and parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.

BMP C103: High-Visibility Fence shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications
- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMP C252: Treating and Disposing of High pH Water is necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation that water can flow through, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands or their buffers. If runoff is allowed to sheetflow through adjacent

vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
- Storm drain inlets shall be protected to prevent sediment-laden water entering the drainage system (see BMP C220: Inlet Protection).

Maintenance Standards
Inspect stabilized areas regularly, especially after large storm events.
Crushed rock, gravel base, etc., shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.

Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.

Perform street cleaning at the end of each day or more often if necessary.

C120 // Temporary and Permanent Seeding

Purpose
Seeding reduces erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use
Use seeding throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.

The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1.

Between July 1 and August 30 seeding requires irrigation until 75 percent grass cover is established.
Between October 1 and March 30 seeding requires a cover of mulch or an erosion control blanket until 75 percent grass cover is established.

Review all disturbed areas in late August to early September and complete all seeding by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.

Mulch is required at all times for seeding because it protects seeds from heat, moisture loss, and transport due to runoff. Mulch can be applied on top of the seed or simultaneously by hydroseeding. See BMP C121: Mulching for specifications.

Seed and mulch all disturbed areas not otherwise vegetated at final site stabilization. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions, or geotextiles) which will prevent erosion. See BMP T5.13: Post-Construction Soil Quality and Depth.

Design and Installation Specifications
General

- Install channels intended for vegetation before starting major earthwork and hydroseed with a Bonded Fiber Matrix. For vegetated channels that will have high flows, install erosion control blankets over the top of hydroseed. Before allowing water to flow in vegetated channels, establish 75 percent vegetation cover. If vegetated channels cannot be established by seed before water flow; install sod in the channel bottom — over top of hydromulch and erosion control blankets.
- Confirm the installation of all required surface water control measures to prevent seed from washing away.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.
- Areas that will have seeding only and not landscaping may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Re-install native topsoil on the disturbed soil surface before application. See BMP T5.13: Post-Construction Soil Quality and Depth.
- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. To overcome this, consider increasing seed quantities by up to 50 percent.
- Enhance vegetation establishment by dividing the hydromulch operation into two phases:
    - Phase 1- Install all seed and fertilizer with 25-30 percent mulch and tackifier onto soil in the first lift.
    - Phase 2- Install the rest of the mulch and tackifier over the first lift.

  Or, enhance vegetation by:
    - Installing the mulch, seed, fertilizer, and tackifier in one lift.
    - Spread or blow straw over the top of the hydromulch at a rate of 800-1000 pounds per acre.
    - Hold straw in place with a standard tackifier.

  Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:
    - Irrigation.
    - Reapplication of mulch.
    - Repair of failed slope surfaces.

  This technique works with standard hydromulch (1,500 pounds per acre minimum) and Bonded Fiber Matrix/ Mechanically Bonded Fiber Matrix (BFM/MBFMs) (3,000 pounds per acre minimum).
- Seed may be installed by hand if:
    - Temporary and covered by straw, mulch, or topsoil.
    - Permanent in small areas (usually less than 1 acre) and covered with mulch, topsoil, or erosion blankets.
- The seed mixes listed in Table II-3.4: Temporary and Permanent Seed Mixes include recommended mixes for both temporary and permanent seeding.
- Apply these mixes, with the exception of the wet area seed mix, at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used. Apply the wet area seed mix at a rate of 60 pounds per acre.
- Consult the local suppliers or the local conservation district for their recommendations. The appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the local authority may be used, depending on the soil type and hydrology of the area.

Table II-3.4: Temporary and Permanent Seed Mixes

Common Name	Latin Name	% Weight	% Purity	% Germination
Temporary Erosion Control Seed Mix A standard mix for areas requiring a temporary vegetative cover.				
Chewings or annual blue grass	*Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye	*Lolium perenne*	50	98	90
Redtop or colonial bentgrass	*Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover	*Trifolium repens*	5	98	90
Landscaping Seed Mix A recommended mix for landscaping seed.				
Perennial rye blend	*Lolium perenne*	70	98	90
Chewings and red fescue blend	*Festuca rubra var. commutata* or *Festuca rubra*	30	98	90
Low-Growing Turf Seed Mix A turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.				
Dwarf tall fescue (several varieties)	*Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay)	*Lolium perenne var. barclay*	30	98	90
Red fescue	*Festuca rubra*	20	98	90
Colonial bentgrass	*Agrostis tenuis*	5	98	90
Bioswale Seed Mix A seed mix for bioswales and other intermittently wet areas.				
Tall or meadow fescue	*Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass	*Agrostis palustris*	10-15	92	85
Redtop bentgrass	*Agrostis alba* or *Agrostis gigantea*	5-10	90	80
Wet Area Seed Mix A low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.				
Tall or meadow fescue	*Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass	*Agrostis palustris*	10-15	98	85
Meadow foxtail	*Alepocurus pratensis*	10-15	90	80
Alsike clover	*Trifolium hybridum*	1-6	98	90
Redtop bentgrass	*Agrostis alba*	1-6	92	85
Meadow Seed Mix A recommended meadow seed mix for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.				
Redtop or Oregon bentgrass	*Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue	*Festuca rubra*	70	98	90

Table II-3.4: Temporary and Permanent Seed Mixes

Common Name	Latin Name	% Weight	% Purity	% Germination
White dutch clover	*Trifolium repens*	10	98	90

Roughening and Rototilling

- The seedbed should be firm and rough. Roughen all soil no matter what the slope. Track walk slopes before seeding if engineering purposes require compaction. Backblading or smoothing of slopes greater than 4H:1V is not allowed if they are to be seeded.
- Restoration-based landscape practices require deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical, initially rip the subgrade to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches complete the rototilling process in multiple lifts, or prepare the engineered soil system per specifications and place to achieve the specified depth.

Fertilizers

- Conducting soil tests to determine the exact type and quantity of fertilizer is recommended. This will prevent the over-application of fertilizer.
- Organic matter is the most appropriate form of fertilizer because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form.
- In general, use 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer at a rate of 90 pounds per acre. Always use slow-release fertilizers because they are more efficient and have fewer environmental impacts. Do not add fertilizer to the hydromulch machine, or agitate, more than 20 minutes before use. Too much agitation destroys the slow-release coating.
- There are numerous products available that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal provides a good source of long-term, slow-release, available nitrogen.

Bonded Fiber Matrix and Mechanically Bonded Fiber Matrix

- On steep slopes use Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products. Apply BFM/MBFM products at a minimum rate of 3,000 pounds per acre with approximately 10 percent tackifier. Achieve a minimum of 95 percent soil coverage during application. Numerous products are available commercially. Most products require 24-36 hours to cure before rainfall and cannot be installed on wet or saturated soils. Generally, products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.
- Install products per manufacturer's instructions.
- BFMs and MBFMs provide good alternatives to blankets in most areas requiring vegetation establishment. Advantages over blankets include:
    - BFM and MBFMs do not require surface preparation.
    - Helicopters can assist in installing BFM and MBFMs in remote areas.
    - On slopes steeper than 2.5H:1V, blanket installers may require ropes and harnesses for safety.

- Installing BFM and MBFMs can save at least $1,000 per acre compared to blankets.

Maintenance Standards

Reseed any seeded areas that fail to establish at least 75 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, use an alternate method such as sodding, mulching, nets, or blankets.

- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

C121 // Mulching

Purpose

Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There are a variety of mulches that can be used. This section discusses only the most common types of mulch.

Conditions of Use

As a temporary cover measure, mulch should be used:

- For less than 30 days on disturbed areas that require cover.
- At all times for seeded areas, especially during the wet season and during the hot summer months.
- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.

Mulch may be applied at any time of the year and must be refreshed periodically.
For seeded areas, mulch may be made up of 100 percent:

- cottonseed meal;
- fibers made of wood, recycled cellulose, hemp, or kenaf;
- compost;
- or blends of these.

Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers.

Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.
Recycled cellulose may contain polychlorinated biphenyl (PCBs). Ecology recommends that products should be evaluated for PCBs prior to use.

Refer to BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection for conditions of use. PAM shall not be directly applied to water or allowed to enter a water body.

Any mulch or tackifier product used shall be installed per the manufacturer's instructions.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table II-3.6: Mulch Standards and Guidelines. Consult with the local supplier or the local conservation district for their recommendations. Increase the application rate until the ground is 95% covered (i.e. not visible under the mulch layer). Note:

Thickness may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Where the option of "Compost" is selected, it should be a coarse compost that meets the size gradations listed in Table II-3.5: Size Gradations of Compost as Mulch Material when tested in accordance with Test Method 02.02-B found in *Test Methods for the Examination of Composting and Compost* (Thompson, 2001).

Table II-3.5: Size Gradations of Compost as Mulch Material

Sieve Size	Percent Passing
3"	100%
1"	90% - 100%
3/4"	70% - 100%
1/4"	40% - 100%

Mulch used within the ordinary high-water mark of surface waters should be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material. Consult the Hydraulic Permit Authority (HPA) for mulch mixes if applicable.

Maintenance Standards
The thickness of the mulch cover must be maintained.

Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

Table II-3.6: Mulch Standards and Guidelines

Mulch Material	Guideline	Description
Straw	**Quality Standards**	Air-dried; free from undesirable seed and coarse material.
	Application Rates	2"-3" thick; 5 bales per 1,000 sf or 2-3 tons per acre
	Remarks	Cost-effective protection when applied with adequate thickness. Hand-application generally requires greater thickness than blown straw. The thickness of straw may be reduced by half when used in conjunction with seeding. In windy areas straw must be held in place by crimping, using a tackifier, or covering with netting. Blown straw always has to be held in place with a tackifier as even light winds will blow it away. Straw, however, has several deficiencies that should be considered when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and it has no significant long-term benefits It should also not be used within the ordinary high-water elevation of surface waters (due to flotation).

Table II-3.6: Mulch Standards and Guidelines

Mulch Material	Guideline	Description
Hydromulch	**Quality Standards**	No growth inhibiting factors.
	Application Rates	Approx. 35-45 lbs per 1,000 sf or 1,500 - 2,000 lbs per acre
	Remarks	Shall be applied with hydromulcher. Shall not be used without seed and tackifier unless the application rate is at least doubled. Fibers longer than about 3/4 - 1 inch clog hydromulch equipment. Fibers should be kept to less than 3/4 inch.
Compost	**Quality Standards**	No visible water or dust during handling. Must be produced per WAC 173-350, Solid Waste Handling Standards, but may have up to 35% biosolids.
	Application Rates	2" thick min.; approx. 100 tons per acre (approx. 750 lbs per cubic yard)
	Remarks	More effective control can be obtained by increasing thickness to 3". Excellent mulch for protecting final grades until landscaping because it can be directly seeded or tilled into soil as an amendment. Compost used for mulch has a coarser size gradation than compost used for BMP C125: Topsoiling / Composting or BMP T5.13: Post-Construction Soil Quality and Depth. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use near wetlands or near phosphorous impaired water bodies.
Chipped Site Vegetation	**Quality Standards**	Gradations from fines to 6 inches in length for texture, variation, and interlocking properties. Include a mix of various sizes so that the average size is between 2- and 4- inches.
	Application Rates	2" thick min.;
	Remarks	This is a cost-effective way to dispose of debris from clearing and grubbing, and it eliminates the problems associated with burning. Generally, it should not be used on slopes above approx. 10% because of its tendency to be transported by runoff. It is not recommended within 200 feet of surface waters. If permanent seeding or planting is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment. Note: thick application of this material over existing grass, herbaceous species, and some groundcovers could smother and kill vegetation.
Wood-Based Mulch	**Quality Standards**	No visible water or dust during handling. Must be purchased from a supplier with a Solid Waste Handling Permit or one exempt from solid waste regulations.
	Application Rates	2" thick min.; approx. 100 tons per acre (approx. 750 lbs. per cubic yard)
	Remarks	This material is often called "wood straw" or "hog fuel". The use of mulch ultimately improves the organic matter in the soil. Special caution is advised regarding the source and composition of wood-based mulches. Its preparation typically does not provide any weed seed control, so evidence of residual vegetation in its composition or known inclusion of weed plants or seeds should be monitored and prevented (or minimized).
Wood Strand Mulch	**Quality Standards**	A blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length-to-width ratio.
	Application Rates	2" thick min.

Table II-3.6: Mulch Standards and Guidelines

Mulch Material	Guideline	Description
	Remarks	Cost-effective protection when applied with adequate thickness. A minimum of 95-percent of the wood strand shall have lengths between 2 and 10-inches, with a width and thickness between 1/16 and 1/2-inches. The mulch shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life. Sawdust or wood shavings shall not be used as mulch. [Specification 9-14.4(4) from the *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT, 2016)

C123 // Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.

- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. However, the relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for applications greater than six months.
- Due to rapid runoff caused by plastic covering, do not use this method upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- Plastic sheeting may result in increased runoff volumes and velocities, requiring additional on-site measures to counteract the increases. Creating a trough with wattles or other material can convey clean water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- Although the plastic material is inexpensive to purchase, the cost of installation, maintenance, removal, and disposal add to the total costs of this BMP.
- Whenever plastic is used to protect slopes, install water collection measures at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to convey clean rainwater away from bare soil and disturbed areas. Do not mix clean runoff from a plastic covered slope with dirty runoff from a project.
- Other uses for plastic include:
    - Temporary ditch liner.
    - Pond liner in temporary sediment pond.
    - Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
    - Emergency slope protection during heavy rains.
    - Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
    1. Run plastic up and down the slope, not across the slope.

2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
3. Provide a minimum of 8-inch overlap at the seams.
4. On long or wide slopes, or slopes subject to wind, tape all seams.
5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and tie them together with twine to hold them in place.
7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil, which causes extreme erosion.
8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.

- Plastic sheeting shall have a minimum thickness of 6 mil.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- Completely remove and replace the plastic if it begins to deteriorate due to ultraviolet radiation.
- Completely remove plastic when no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

C140 // Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

Use dust control in areas (including roadways) subject to surface and air movement of dust where on-site or off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until the surface is wet. Repeat as needed. To prevent carryout of mud onto the street, refer to BMP C105: Stabilized Construction Access and BMP C106: Wheel Wash.
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.

- PAM (BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection) added to water at a rate of 0.5 pounds per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may reduce the quantity of water needed for dust control. Note that the application rate specified here applies to this BMP, and is not the same application rate that is specified in BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection, but the downstream protections still apply.
  Refer to BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection for conditions of use. PAM shall not be directly applied to water or allowed to enter a water body.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Techniques that can be used for unpaved roads and lots include:
  - Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
  - Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
  - Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.
  - Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
  - Encourage the use of alternate, paved routes, if available.
  - Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
  - Limit dust-causing work on windy days.
  - Pave unpaved permanent roads and other trafficked areas.

Maintenance Standards
Respray area as necessary to keep dust to a minimum.

C150 // Materials on Hand

Purpose
Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy rains. Having these materials on-site reduces the time needed to replace existing or implement new BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel “T” posts.

- Materials should be stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or project proponent could keep a stockpile of materials that are available for use on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum list of items that will cover numerous situations includes:

- Clear Plastic, 6 mil
- Drainpipe, 6 or 8 inch diameter
- Sandbags, filled
- Straw Bales for mulching
- Quarry Spalls
- Washed Gravel
- Geotextile Fabric
- Catch Basin Inserts
- Steel "T" Posts
- Silt fence material
- Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel “T” posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials as needed.

C151 // Concrete Handling

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the State.

Conditions of Use

Any time concrete is used, utilize these management practices. Concrete construction project components include, but are not limited to:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

Disposal options for concrete, in order of preference are:

1. Off-site disposal
2. Concrete wash-out areas (see BMP C154: Concrete Washout Area)
3. De minimus washout to formed areas awaiting concrete

Design and Installation Specifications

- Wash concrete truck drums at an approved off-site location or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground (including formed areas awaiting concrete), or into storm drains, open ditches, streets, or streams. Refer to BMP C154: Concrete Washout Area for information on concrete washout areas.
    - Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete on site, except in designated concrete washout areas as allowed in BMP C154: Concrete Washout Area.
- Wash small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) into designated concrete washout areas or into formed areas awaiting concrete pour.
- At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.
- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow washwater from areas, such as concrete aggregate driveways, to drain directly (without detention or treatment) to natural or constructed stormwater conveyances.
- Contain washwater and leftover product in a lined container when no designated concrete washout areas (or formed areas, allowed as described above) are available. Dispose of contained concrete and concrete washwater (process water) properly.
- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMP C252: Treating and Disposing of High pH Water for pH adjustment requirements.
- Refer to the Construction Stormwater General Permit (CSWGP) for pH monitoring requirements if the project involves one of the following activities:
    - Significant concrete work (as defined in the CSWGP).
    - The use of soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.
    - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

Check containers for holes in the liner daily during concrete pours and repair the same day.

C152 // Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to:

- Sawing
- Coring

- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose of collected slurry and cuttings in a manner that does not violate ground water or surface water quality standards.

- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose of process water in a manner that does not violate ground water or surface water quality standards.
- Handle and dispose of cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and/or vacuum trucks.

C153 // Material Delivery, Storage and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials on-site, store materials in a designated area, and install secondary containment.

Conditions of Use

Use at construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g., Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents, and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

- The temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.

- Safety Data Sheets (SDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on-site should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as an earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, within secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.
- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.
- Temporary secondary containment facilities shall provide for a spill containment volume able to contain 10% of the total enclosed container volume of all containers, or 110% of the capacity of the largest container within its boundary, whichever is greater.
- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- During the wet weather season (Oct 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.
- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).
- The spill kit should include, at a minimum:
    - 1-Water Resistant Nylon Bag
    - 3-Oil Absorbent Socks 3"x 4'
    - 2-Oil Absorbent Socks 3"x 10'
    - 12-Oil Absorbent Pads 17"x19"
    - 1-Pair Splash Resistant Goggles
    - 3-Pair Nitrile Gloves
    - 10-Disposable Bags with Ties
    - Instructions

Maintenance Standards

- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.
- Re-stock spill kit materials as needed.

C154 // Concrete Washout Area

Purpose

Prevent or reduce the discharge of pollutants from concrete waste to stormwater by conducting washout off-site, or performing on-site washout in a designated area.

Conditions of Use

Concrete washout areas are implemented on construction projects where:

- Concrete is used as a construction material
- It is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Concrete truck drums are washed on-site.

Note that auxiliary concrete truck components (e.g. chutes and hoses) and small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) may be washed into formed areas awaiting concrete pour.

At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

Design and Installation Specifications

Implementation

- Perform washout of concrete truck drums at an approved off-site location or in designated concrete washout areas only.
- Do not wash out concrete onto non-formed areas, or into storm drains, open ditches, streets, or streams.
- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas as allowed above.
- Concrete washout areas may be prefabricated concrete washout containers, or self-installed structures (above-grade or below-grade).
- Prefabricated containers are most resistant to damage and protect against spills and leaks. Companies may offer delivery service and provide regular maintenance and disposal of solid and liquid waste.
- If self-installed concrete washout areas are used, below-grade structures are preferred over above-grade structures because they are less prone to spills and leaks.
- Self-installed above-grade structures should only be used if excavation is not practical.
- Concrete washout areas shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

Education

- Discuss the concrete management techniques described in this BMP with the ready-mix concrete supplier before any deliveries are made.
- Educate employees and subcontractors on the concrete waste management techniques described in this BMP.
- Arrange for the contractor's superintendent or Certified Erosion and Sediment Control Lead (CESCL) to oversee and enforce concrete waste management procedures.
- A sign should be installed adjacent to each concrete washout area to inform concrete equipment operators to utilize the proper facilities.

Contracts

Incorporate requirements for concrete waste management into concrete supplier and subcontractor agreements.

Location and Placement

- Locate concrete washout areas at least 50 feet from sensitive areas such as storm drains, open ditches, water bodies, or wetlands.
- Allow convenient access to the concrete washout area for concrete trucks, preferably near the area where the concrete is being poured.
- If trucks need to leave a paved area to access the concrete washout area, prevent track-out with a pad of rock or quarry spalls (see BMP C105: Stabilized Construction Access). These areas should be far enough away from other construction traffic to reduce the likelihood of accidental damage and spills.
- The number of concrete washout areas you install should depend on the expected demand for storage capacity.
- On large sites with extensive concrete work, concrete washout areas should be placed in multiple locations for ease of use by concrete truck drivers.

Concrete Truck Washout Procedures

- Washout of concrete truck drums shall be performed in designated concrete washout areas only.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated concrete washout areas or properly disposed of off-site.

Concrete Washout Area Installation

- Concrete washout areas should be constructed as shown in the figures below, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
- Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
- Lath and flagging should be commercial type.
- Liner seams shall be installed in accordance with manufacturers' recommendations.
- Soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.

Maintenance Standards

Inspection and Maintenance

- Inspect and verify that concrete washout areas are in place prior to the commencement of concrete work.
- Once concrete wastes are washed into the designated washout area and allowed to harden, the concrete should be broken up, removed, and disposed of per applicable solid waste regulations. Dispose of hardened concrete on a regular basis.
- During periods of concrete work, inspect the concrete washout areas daily to verify continued performance.
    - Check overall condition and performance.
    - Check remaining capacity (% full).
    - If using self-installed concrete washout areas, verify plastic liners are intact and sidewalls are not damaged.
    - If using prefabricated containers, check for leaks.
- Maintain the concrete washout areas to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Concrete washout areas must be cleaned, or new concrete washout areas must be constructed and ready for use once the concrete washout area is 75% full.
- If the concrete washout area is nearing capacity, vacuum and dispose of the waste material in an approved manner.

  - Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
  - Do not discharge to the sanitary sewer without local approval.
  - Place a secure, non-collapsing, non-water collecting cover over the concrete washout area prior to predicted wet weather to prevent accumulation and overflow of precipitation.
  - Remove and dispose of hardened concrete and return the structure to a functional condition. Concrete may be reused on-site or hauled away for disposal or recycling.
- When you remove materials from a self-installed concrete washout area, build a new structure; or, if the previous structure is still intact, inspect for signs of weakening or damage, and make any necessary repairs. Re-line the structure with new plastic after each cleaning.

Removal of Concrete Washout Areas

- When concrete washout areas are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.
- Materials used to construct concrete washout areas shall be removed from the site of the work and disposed of or recycled.
- Holes, depressions or other ground disturbance caused by the removal of the concrete washout areas shall be backfilled, repaired, and stabilized to prevent erosion.

C160 // Certified Erosion and Sediment Control Lead

Purpose

The project proponent designates at least one person as the responsible representative in charge of erosion and sediment control (ESC), and water quality protection. The designated person shall be responsible for ensuring compliance with all local, state, and federal erosion and sediment control and water quality requirements. Construction sites one acre or larger that discharge to waters of the State must designate a Certified Erosion and Sediment Control Lead (CESCL) as the responsible representative.

Conditions of Use

A CESCL shall be made available on projects one acre or larger that discharge stormwater to surface waters of the state. Sites less than one acre may have a person without CESCL certification conduct inspections.

The CESCL shall:

- Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum ESC training and certification requirements established by Ecology.
  Ecology has provided the minimum requirements for CESCL course training, as well as a list of ESC training and certification providers at:
  https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Certified-erosion-sediment-control
  OR
- Be a Certified Professional in Erosion and Sediment Control (CPESC). For additional information go to: http://www.envirocertintl.org/cpesc/

Specifications

- CESCL certification shall remain valid for three years.
- The CESCL shall have authority to act on behalf of the contractor or project proponent and shall be available, or on-call, 24 hours per day throughout the period of construction.

- The Construction SWPPP shall include the name, telephone number, fax number, and address of the designated CESCL. See II-2 Construction Stormwater Pollution Prevention Plans (Construction SWPPPs).
- A CESCL may provide inspection and compliance services for multiple construction projects in the same geographic region, but must be on site whenever earthwork activities are occurring that could generate release of turbid water.
- Duties and responsibilities of the CESCL shall include, but are not limited to the following:
    - Maintaining a permit file on site at all times which includes the Construction SWPPP and any associated permits and plans.
    - Directing BMP installation, inspection, maintenance, modification, and removal.
    - Updating all project drawings and the Construction SWPPP with changes made.
    - Completing any sampling requirements including reporting results using electronic Discharge Monitoring Reports (WebDMR).
    - Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.
    - Keeping daily logs, and inspection reports. Inspection reports should include:
        - Inspection date/time.
        - Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
        - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
        - Any water quality monitoring performed during inspection.
        - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
        - A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
            1. Locations of BMPs inspected.
            2. Locations of BMPs that need maintenance.
            3. Locations of BMPs that failed to operate as designed or intended.
            4. Locations of where additional or different BMPs are required.

II-3.3 Construction Runoff BMPs

C200 // Interceptor Dike and Swale

Purpose

Provide a dike of compacted soil or a swale at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.

Conditions of Use

Use an interceptor dike or swale where runoff from an exposed site or disturbed slope must be conveyed to an erosion control BMP which can safely convey the stormwater.

- Locate upslope of a construction site to prevent runoff from entering the disturbed area.

- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.
- Locate downslope to collect runoff from a disturbed area and direct it to a sediment BMP (e.g. BMP C240: Sediment Trap or BMP C241: Sediment Pond (Temporary)).

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Steep grades require channel protection and check dams.
- Review construction for areas where overtopping may occur.
- Can be used at the top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Contributing area for an individual dike or swale should be one acre or less.
- Design the dike and/or swale to contain flows calculated by one of the following methods:
    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the worst-case land cover condition.
      OR
    - Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step for the worst-case land cover condition.

  Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).

Interceptor Dikes

Interceptor dikes shall meet the following criteria:

- Top Width: 2 feet minimum.
- Height: 1.5 feet minimum on berm.
- Side Slope: 2H:1V or flatter.
- Grade: Depends on topography, however, dike system minimum is 0.5%, and maximum is 1%.
- Compaction: Minimum of 90 percent ASTM D698 standard proctor.
- Stabilization: Depends on velocity and reach. Inspect regularly to ensure stability.
- Ground Slopes <5%: Seed and mulch applied within 5 days of dike construction (see BMP C121: Mulching).
- Ground Slopes 5 - 40%: Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap, or other measures to avoid erosion.
- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.
- See Table II-3.8: Horizontal Spacing of Interceptor Dikes Along Ground Slope for recommended horizontal spacing between dikes.

Table II-3.8: Horizontal Spacing of Interceptor Dikes Along Ground Slope

Average Slope	Slope Percent	Flowpath Length
20H:1V or less	3-5%	300 feet

Table II-3.8: Horizontal Spacing of Interceptor Dikes Along Ground Slope

Average Slope	Slope Percent	Flowpath Length
(10 to 20)H:1V	5-10%	200 feet
(4 to 10)H:1V	10-25%	100 feet
(2 to 4)H:1V	25-50%	50 feet

Interceptor Swales

Interceptor swales shall meet the following criteria:

- Bottom Width: 2 feet minimum; the cross-section bottom shall be level.
- Depth: 1-foot minimum.
- Side Slope: 2H:1V or flatter.
- Grade: Maximum 5 percent, with positive drainage to a suitable outlet (such as BMP C241: Sediment Pond (Temporary)).
- Stabilization: Seed as per BMP C120: Temporary and Permanent Seeding, or BMP C202: Riprap Channel Lining, 12 inches thick riprap pressed into the bank and extending at least 8 inches vertical from the bottom.

Maintenance Standards

- Inspect diversion dikes and interceptor swales once a week and after every rainfall. Immediately remove sediment from the flow area.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.
- Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface.

C201 // Grass-Lined Channels

Purpose

To provide a channel with a vegetative lining for conveyance of runoff. The purpose of the vegetative lining is to prevent transport of sediment and erosion.

Conditions of Use

This practice applies to construction sites where concentrated runoff needs to be directed to prevent erosion or flooding.

- Use this BMP when a vegetative lining can provide sufficient stability for the channel cross section and at lower velocities of water (normally dependent on grade). This means that the channel slopes are generally less than 5 percent and space is available for a relatively large cross section.
- Typical uses include roadside ditches, channels at property boundaries, outlets for diversions, and other channels and drainage ditches in low areas.
- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a bonded fiber matrix (BFM). The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch unless BMP C122: Nets and Blankets is used to protect the channel. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch in lieu of hydromulch and blankets.

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Design and Installation Specifications

See Figure II-3.10: Typical Grass-Lined Channels

Locate channels where they can conform to the topography and other features such as roads. Use natural drainage systems to the greatest extent possible

- Avoid sharp changes in alignment or bends and changes in grade.
- Do not reshape the landscape to fit the drainage channel.
- The maximum design velocity shall be based on soil conditions, type of vegetation, and method of revegetation, but at no time shall velocity exceed 5 feet/second. The channel shall not be overtopped by the peak volumetric flow rate calculated by one of the following methods:
    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the worst-case land cover condition.
      OR
    - Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step for the worst-case land cover condition..

  Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).
- Where the grass-lined channel will also function as a permanent stormwater conveyance facility, consult the drainage conveyance requirements of the local jurisdiction.
- An established grass or vegetated lining is required before the channel can be used to convey stormwater, unless stabilized with nets or blankets (See BMP C122: Nets and Blankets).
- If design velocity of a channel to be vegetated by seeding exceeds 2 ft/sec, a temporary channel liner is required. Geotextile or special mulch protection such as fiberglass roving or straw and netting provides stability until the vegetation is fully established. See Figure II-3.11: Temporary Channel Liners.
- Check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- If vegetation is established by sodding, the permissible velocity for established vegetation may be used and no temporary liner is needed.
- Do not subject the grass-lined channel to sedimentation from disturbed areas. Use sediment-trapping BMPs upstream of the channel.
- V-shaped grass channels generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross section is least desirable because it is difficult to stabilize the bottom where velocities may be high.
- Trapezoidal grass channels are used where runoff volumes are large and slope is low so that velocities are nonerosive to vegetated linings. (Note: it is difficult to construct small parabolic shaped channels.)
- Subsurface drainage or riprap channel bottoms may be necessary on sites that are subject to prolonged wet conditions due to long duration flows or a high water table.
- Provide outlet protection at culvert ends and at channel intersections.
- Grass channels, at a minimum, should carry peak runoff for temporary construction drainage facilities from the 10-year, 24-hour storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage.

- Grassed channel side slopes generally are constructed 3H:1V or flatter to aid in the establishment of vegetation and for maintenance.
- Construct channels a minimum of 0.2 foot larger around the periphery to allow for soil bulking during seedbed preparations and sod buildup.

Maintenance Standards

During the establishment period, check grass-lined channels after every rainfall.

- After grass is established, periodically check the channel; check it after every heavy rainfall event. Immediately make repairs.
- Check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes.
- Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.

C207 // Check Dams

Purpose

Construction of check dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam.

Conditions of Use

Use check dams where temporary or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required.

- Check dams may not be placed in streams unless approved by the State Department of Fish and Wildlife.
- Check dams may not be placed in wetlands without approval from a permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.

Design and Installation Specifications

- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed by hand or by mechanical means (do not dump the rock to form the dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.
- Place check dams perpendicular to the flow of water.
- The check dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the check dam rather than falling directly onto the ditch bottom.
- Before installing check dams, impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.
- Check dams combined with sumps work more effectively at slowing flow and retaining sediment than a check dam alone. A deep sump should be provided immediately upstream of the check dam.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case

accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.
- The maximum spacing between check dams shall be such that the downstream toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 2 feet at the center of the check dam.
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2H:1V or flatter.
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, filter fabric is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones.
- See Figure II-3.16: Rock Check Dam.

Maintenance Standards

Check dams shall be monitored for performance and sediment accumulation during and after each rainfall that produces runoff. Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel. See BMP C202: Riprap Channel Lining.

C208 // Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)

Purpose

Triangular silt dikes (TSDs) may be used as check dams, for perimeter protection, for temporary soil stockpile protection, for drop inlet protection, or as a temporary interceptor dike.

Conditions of Use

- TSDs may be used on soil or pavement with adhesive or staples.
- TSDs have been used to build temporary:
  - BMP C241: Sediment Pond (Temporary);
  - BMP C200: Interceptor Dike and Swale;
  - BMP C154: Concrete Washout Area;
  - BMP C203: Water Bars;
  - BMP C206: Level Spreader;
  - BMP C220: Inlet Protection;
  - BMP C207: Check Dams
  - curbing; and
  - berms.

Design and Installation Specifications

- TSDs are made of urethane foam sewn into a woven geosynthetic fabric.
- TSDs are triangular, 10 inches to 14 inches high in the center, with a 20-inch to 28-inch base. A 2 foot apron extends beyond both sides of the triangle along its standard section of 7 feet. A sleeve at one end allows attachment of additional sections as needed.
- Install with ends curved up to prevent water from flowing around the ends.
- The fabric flaps and check dam units are attached to the ground with wire staples. Wire staples should be No. 11 gauge wire and should be 200 mm to 300 mm in length.
- When multiple units are installed, the sleeve of fabric at the end of the unit shall overlap the abutting unit and be stapled.
- When used as check dams:
    - TSDs should be located and installed as soon as construction will allow.
    - TSDs should be placed perpendicular to the flow of water.
    - The leading edge of the TSD must be secured with rocks, sandbags, or a small key slot and staples.
    - In the case of grass-lined ditches and swales, check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Maintenance Standards

- Inspect TSDs for performance and sediment accumulation during and after each rainfall that produces runoff. Remove sediment when it reaches one half the height of the TSD.
- Anticipate submergence and deposition above the TSD and erosion from high flows around the edges of the TSD. Immediately repair any damage or any undercutting of the TSD.

C209 // Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions of Use

Use outlet protection at the outlets of all ponds, pipes, ditches, or other conveyances that discharge to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

- The receiving channel at the outlet of a pipe shall be protected from erosion by lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1–foot above the maximum tailwater elevation, or 1-foot above the crown, whichever is higher. For pipes larger than 18 inches in diameter, the outlet protection lining of the channel shall be four times the diameter of the outlet pipe.
- Standard wingwalls, tapered outlets, and paved channels should also be considered when appropriate for permanent culvert outlet protection (WSDOT, 2015).
- BMP C122: Nets and Blankets or BMP C202: Riprap Channel Lining provide suitable options for lining materials.
- With low flows, BMP C201: Grass-Lined Channels can be an effective alternative for lining material.
- The following guidelines shall be used for outlet protection with riprap:

  - If the discharge velocity at the outlet is less than 5 fps, use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
  - For 5 to 10 fps discharge velocity at the outlet, use 24-inch to 48-inch riprap. Minimum thickness is 2 feet.
  - For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), use an engineered energy dissipator.
  - Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion. See BMP C122: Nets and Blankets.
- Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a Hydraulic Project Approval (HPA) from the Washington State Department of Fish and Wildlife. See I-2.11 Hydraulic Project Approvals.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipator if sediment builds up.

C220 // Storm Drain Inlet Protection

Purpose

Inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use inlet protection at inlets that are operational before permanent stabilization of the disturbed areas that contribute runoff to the inlet. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless those inlets are preceded by a sediment trapping BMP.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters can add significant amounts of sediment into the roof drain system. If possible, delay installing lawn and yard drains until just before landscaping, or cap these drains to prevent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table II-3.10: Storm Drain Inlet Protection lists several options for inlet protection. All of the methods for inlet protection tend to plug and require a high frequency of maintenance. Limit contributing drainage areas for an individual inlet to one acre or less. If possible, provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table II-3.10: Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Drop Inlet Protection			

Table II-3.10: Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Excavated drop inlet protection	Yes, temporary flooding may occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area requirement: 30'x30'/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No	Paved or Earthen	Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap	N/A	N/A	18 month expected life.

Design and Installation Specifications

Excavated Drop Inlet Protection

Excavated drop inlet protection consists of an excavated impoundment around the storm drain inlet. Sediment settles out of the stormwater prior to entering the storm drain. Design and installation specifications for excavated drop inlet protection include:

- Provide a depth of 1-2 ft as measured from the crest of the inlet structure.
- Slope sides of excavation should be no steeper than 2H:1V.
- Minimum volume of excavation is 35 cubic yards.
- Shape the excavation to fit the site, with the longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.
- Build a temporary dike, if necessary, to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter

A block and gravel filter is a barrier formed around the inlet with standard concrete blocks and gravel. See Figure II-3.17: Block and Gravel Filter. Design and installation specifications for block gravel filters include:

- Provide a height of 1 to 2 feet above the inlet.
- Recess the first row of blocks 2-inches into the ground for stability.
- Support subsequent courses by placing a pressure treated wood 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side to allow for dewatering the pool.

- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel to just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel berm surrounding the inlet, as follows:
    - Provide a slope of 3H:1V on the upstream side of the berm.
    - Provide a slope of 2H:1V on the downstream side of the berm.
    - Provide a 1-foot wide level stone area between the gravel berm and the inlet.
    - Use stones 3 inches in diameter or larger on the upstream slope of the berm.
    - Use gravel ½- to ¾-inch at a minimum thickness of 1-foot on the downstream slope of the berm.

Gravel and Wire Mesh Filter

Gravel and wire mesh filters are gravel barriers placed over the top of the inlet. This method does not provide an overflow. Design and installation specifications for gravel and wire mesh filters include:

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
    - Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
    - Overlap the strips if more than one strip of mesh is necessary.
- Place coarse aggregate over the wire mesh.
    - Provide at least a 12-inch depth of aggregate over the entire inlet opening and extend at least 18-inches on all sides.

Catch Basin Filters

Catch basin filters are designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements, combine a catch basin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way. Design and installation specifications for catch basin filters include:

- Provides 5 cubic feet of storage.
- Requires dewatering provisions.
- Provides a high-flow bypass that will not clog under normal use at a construction site.
- Insert the catch basin filter in the catch basin just below the grating.

Curb Inlet Protection with Wooden Weir

Curb inlet protection with wooden weir is an option that consists of a barrier formed around a curb inlet with a wooden frame and gravel. Design and installation specifications for curb inlet protection with wooden weirs include:

- Use wire mesh with ½-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against the wire and fabric.
- Place weight on the frame anchors.

Block and Gravel Curb Inlet Protection

Block and gravel curb inlet protection is a barrier formed around a curb inlet with concrete blocks and gravel. See Figure II-3.18: Block and Gravel Curb Inlet Protection. Design and installation specifications for block and gravel curb inlet protection include:

- Use wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.

- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

Curb and Gutter Sediment Barrier

Curb and gutter sediment barrier is a sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure II-3.19: Curb and Gutter Barrier. Design and installation specifications for curb and gutter sediment barrier include:

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the upstream side of the berm. Size the trap to sediment trap standards for protecting a culvert inlet.

Maintenance Standards

- Inspect all forms of inlet protection frequently, especially after storm events. Clean and replace clogged catch basin filters. For rock and gravel filters, pull away the rocks from the inlet and clean or replace. An alternative approach would be to use the clogged rock as fill and put fresh rock around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

C233 // Silt Fence

Purpose

Silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence shall prevent sediment carried by runoff from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment trapping BMP.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

Design and Installation Specifications

- Use in combination with other construction stormwater BMPs.
- Maximum slope steepness (perpendicular to the silt fence line) 1H:1V.
- Maximum sheet or overland flow path length to the silt fence of 100 feet.
- Do not allow flows greater than 0.5 cfs.
- Use geotextile fabric that meets the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table II-3.11: Geotextile Fabric Standards for Silt Fence):

Table II-3.11: Geotextile Fabric Standards for Silt Fence

Geotextile Property	Minimum Average Roll Value
Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film woven (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Support standard strength geotextiles with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the geotextile. Silt fence materials are available that have synthetic mesh backing attached.
- Silt fence material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F to 120°F.
- One-hundred percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by the local jurisdiction.
- Refer to Figure II-3.22: Silt Fence for standard silt fence details. Include the following Standard Notes for silt fence on construction plans and specifications:
    1. The Contractor shall install and maintain temporary silt fences at the locations shown in the Plans.
    2. Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.
    3. The silt fence shall have a 2-feet min. and a 2½-feet max. height above the original ground surface.
    4. The geotextile fabric shall be sewn together at the point of manufacture to form fabric lengths as required. Locate all sewn seams at support posts. Alternatively, two sections of silt fence can be overlapped, provided that the overlap is long enough and that the adjacent silt fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.
    5. Attach the geotextile fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the geotextile fabric to the posts in a manner that reduces the potential for tearing.
    6. Support the geotextile fabric with wire or plastic mesh, dependent on the properties of the geotextile selected for use. If wire or plastic mesh is used, fasten the mesh securely to the up-slope side of the posts with the geotextile fabric up-slope of the mesh.
    7. Mesh support, if used, shall consist of steel wire with a maximum mesh spacing of 2-inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the geotextile fabric it supports.

8. Bury the bottom of the geotextile fabric 4-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the geotextile fabric, so that no flow can pass beneath the silt fence and scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the ground 3-inches min.
9. Drive or place the silt fence posts into the ground 18-inches min. A 12–inch min. depth is allowed if topsoil or other soft subgrade soil is not present and 18-inches cannot be reached. Increase fence post min. depths by 6 inches if the fence is located on slopes of 3H:1V or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.
10. Use wood, steel or equivalent posts. The spacing of the support posts shall be a maximum of 6-feet. Posts shall consist of either:
    - Wood with minimum dimensions of 2 inches by 2 inches by 3 feet. Wood shall be free of defects such as knots, splits, or gouges.
    - No. 6 steel rebar or larger.
    - ASTM A 120 steel pipe with a minimum diameter of 1-inch.
    - U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft.
    - Other steel posts having equivalent strength and bending resistance to the post sizes listed above.
11. Locate silt fences on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.
12. If the fence must cross contours, with the exception of the ends of the fence, place check dams perpendicular to the back of the fence to minimize concentrated flow and erosion. The slope of the fence line where contours must be crossed shall not be steeper than 3H:1V.
    - Check dams shall be approximately 1-foot deep at the back of the fence. Check dams shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.
    - Check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Check dams shall be located every 10 feet along the fence where the fence must cross contours.

- Refer to Figure II-3.23: Silt Fence Installation by Slicing Method for slicing method details. The following are specifications for silt fence installation using the slicing method:
    1. The base of both end posts must be at least 2- to 4-inches above the top of the geotextile fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
    2. Install posts 3- to 4-feet apart in critical retention areas and 6- to 7-feet apart in standard applications.
    3. Install posts 24-inches deep on the downstream side of the silt fence, and as close as possible to the geotextile fabric, enabling posts to support the geotextile fabric from upstream water pressure.
    4. Install posts with the nipples facing away from the geotextile fabric.
    5. Attach the geotextile fabric to each post with three ties, all spaced within the top 8-inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with

each puncture at least 1-inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening to prevent sagging.

6. Wrap approximately 6-inches of the geotextile fabric around the end posts and secure with 3 ties.
7. No more than 24-inches of a 36-inch geotextile fabric is allowed above ground level.
8. Compact the soil immediately next to the geotextile fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips. Check and correct the silt fence installation for any deviation before compaction. Use a flat-bladed shovel to tuck the fabric deeper into the ground if necessary.

Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment trapping BMP.
- Check the uphill side of the silt fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence and remove the trapped sediment.
- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace geotextile fabric that has deteriorated due to ultraviolet breakdown.

C235 // Wattles

Purpose

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in netting made of natural plant fiber or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment.

Conditions of Use

- Wattles shall consist of cylinders of plant material such as weed-free straw, coir, wood chips, excelsior, or wood fiber or shavings encased within netting made of natural plant fibers unaltered by synthetic materials.
- Use wattles:
  - In disturbed areas that require immediate erosion protection.
  - On exposed soils during the period of short construction delays, or over winter months.
  - On slopes requiring stabilization until permanent vegetation can be established.
- The material used dictates the effectiveness period of the wattle. Generally, wattles are effective for one to two seasons.
- Prevent rilling beneath wattles by entrenching and overlapping wattles to prevent water from passing between them.

Design Criteria

- See Figure II-3.24: Wattles for typical construction details.
- Wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length.
- Install wattles perpendicular to the flow direction and parallel to the slope contour.

- Place wattles in shallow trenches, staked along the contour of disturbed or newly constructed slopes. Dig narrow trenches across the slope (on contour) to a depth of 3- to 5-inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5- to 7- inches, or 1/2 to 2/3 of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Spread excavated material evenly along the uphill slope and compact it using hand tamping or other methods.
- Construct trenches at intervals of 10- to 25-feet depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches.
- Install the wattles snugly into the trenches and overlap the ends of adjacent wattles 12 inches behind one another.
- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle.
- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.
- Wooden stakes should be approximately 0.75 x 0.75 x 24 inches min. Willow cuttings or 3/8-inch rebar can also be used for stakes.
- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.

Maintenance Standards

- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils.
- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.

C241 // Temporary Sediment Pond

Purpose

Sediment ponds are temporary ponds used during construction to remove sediment from runoff originating from disturbed areas of the project site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

- Use a sediment pond where the contributing drainage area to the pond is 3 acres or more. Ponds must be used in conjunction with other Construction Stormwater BMPs to reduce the amount of sediment flowing into the pond.
- Do not install sediment ponds on sites where failure of the BMP would result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment ponds are attractive to children and can be dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, show the type of fence and its location on the drawings in the Construction SWPPP.
- Sediment ponds that can impound 10 acre-ft (435,600 cu-ft, or 3.26 million gallons) or more, or have an embankment of more than 6 feet, are subject to the Washington Dam Safety Regulations (Chapter 173-175 WAC). See BMP D.1: Detention Ponds for more information regarding dam safety considerations for detention ponds.
- Projects that are constructing permanent Flow Control BMPs or Runoff Treatment BMPs that use ponding for treatment may use the rough-graded or final-graded permanent BMP footprint for the temporary sediment pond. When permanent BMP footprints are used as temporary sediment ponds, the surface area requirement of the temporary sediment pond must be met. If the surface

area requirement of the sediment pond is larger than the surface area of the permanent BMP, then the sediment pond shall be enlarged beyond the permanent BMP footprint to comply with the surface area requirement.

The permanent control structure must be temporarily replaced with a control structure that only allows water to leave the temporary sediment pond from the surface or by pumping. Alternatively, the permanent control structure may used if it is temporarily modified by plugging any outlet holes below the riser. The permanent control structure must be installed as part of the permanent BMP after the site is fully stabilized.

Design and Installation Specifications

General

- See Figure II-3.28: Sediment Pond Plan View, Figure II-3.29: Sediment Pond Cross Section, and Figure II-3.30: Sediment Pond Riser Detail for details.
- Use of permanent infiltration BMP footprints for temporary sediment ponds during construction tends to clog the soils and reduce their capacity to infiltrate. If permanent infiltration BMP footprints are used, the sides and bottom of the temporary sediment pond must only be rough excavated to a minimum of 2 feet above final grade of the permanent infiltration BMP. Final grading of the permanent infiltration BMP shall occur only when all contributing drainage areas are fully stabilized. Any proposed permanent pretreatment BMP prior to the infiltration BMP should be fully constructed and used with the temporary sediment pond to help prevent clogging of the soils. See Element 13: Protect Low Impact Development BMPs for more information about protecting permanent infiltration BMPs.
- The pond shall be divided into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between the cells. The divider shall be at least one-half the height of the riser, and at least one foot below the top of the riser. Wire-backed, 2- to 3-foot high, high strength geotextile fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with geotextile fabric may be used. If the pond is more than 6 feet deep, a different divider design must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent erosion under and around the divider.
- The most common structural failure of sediment ponds is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

  The most critical construction practices to prevent piping are:
  - Tight connections between the riser and outlet pipe, and other pipe connections.
  - Adequate anchoring of the riser.
  - Proper soil compaction of the embankment and riser footing.
  - Proper construction of anti-seep devices.

Sediment Pond Geometry

To determine the sediment pond geometry, first calculate the design surface area (SA) of the pond, measured at the top of the riser pipe. Use the following equation:

$$SA = 2 \times Q_2/0.00096$$

or

2080 square feet per cfs of inflow

See BMP C240: Sediment Trap for more information on the above equation.

The basic geometry of the pond can now be determined using the following design criteria:

- Required surface area SA (from the equation above) at the top of the riser.
- Minimum 3.5-foot depth from the top of the riser to the bottom of the pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum water surface.
- One foot of freeboard between the top of the riser and the crest of the emergency spillway.
- Flat bottom.
- Minimum 1-foot deep spillway.
- Length-to-width ratio between 3:1 and 6:1.

Sediment Pond Discharge

The outlet for the pond consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year storm. If, due to site conditions and basin geometry, a separate emergency spillway is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year storm. However, an attempt to provide a separate emergency spillway should always be made. Base the runoff calculations on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100-year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.
The principal spillway designed by the procedures described below will result in some reduction in the peak rate of runoff. However, the design will not control the discharge flow rates to the extent required to comply with I-3.4.7 MR7: Flow Control. The size of the contributing basin, the expected life of the construction project, the anticipated downstream effects, and the anticipated weather conditions during construction should be considered to determine the need for additional discharge control.

Principal Spillway: Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the peak volumetric flow rate using a 15-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Use Figure II-3.31: Riser Inflow Curves to determine the riser diameter.

To aid in determining sediment depth, one-foot intervals shall be prominently marked on the riser.

Emergency Overflow Spillway: Size the emergency overflow spillway for the peak volumetric flow rate using a 10-minute time step from a Type 1A, 100-year, 24-hour frequency storm for the developed condition. See BMP D.1: Detention Ponds for additional guidance for Emergency Overflow Spillway design

Dewatering Orifice: Size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A_S(2h)^{0.5}}{0.6 \times 3600 T g^{0.5}}$$

where
A_o = orifice area (square feet)
A_S = pond surface area (square feet)
h = head of water above orifice (height of riser in feet)
T = dewatering time (24 hours)
g = acceleration of gravity (32.2 feet/second^2)
Convert the orifice area (in square feet) to the orifice diameter D (in inches):

$$D = 24 \times \sqrt{\frac{A_o}{\pi}} = 13.54 \times \sqrt{A_o}$$

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

Maintenance Standards

- Remove sediment from the pond when it reaches 1 foot in depth.
- Repair any damage to the pond embankments or slopes.

C251// Construction Stormwater Filtration

Purpose

Filtration removes sediment from runoff originating from disturbed areas of the site.

Conditions of Use

Traditional Construction Stormwater BMPs used to control soil erosion and sediment loss from construction sites may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity will be dependent on the particle size distribution of the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity.

The use of construction stormwater filtration does not require approval from Ecology as long as treatment chemicals are not used. Filtration in conjunction with BMP C250: Construction Stormwater Chemical Treatment requires testing under the Chemical Technology Assessment Protocol – Ecology (CTAPE) before it can be initiated. Approval from Ecology must be obtained at each site where chemical use is proposed prior to use. See https://fortress.wa.gov/ecy/publications/SummaryPages/ecy070258.html for a copy of the Request for Chemical Treatment form.

Design and Installation Specifications

Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow.

Rapid filtration systems are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids.

Slow filtration systems have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. Slow filtration systems have generally been used as post construction BMPs to treat stormwater (see V-6 Filtration BMPs). Slow filtration is mechanically simple in comparison to rapid filtration, but requires a much larger filter area.

Filter Types and Efficiencies

Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm. Filters should be sequenced from the largest to the smallest pore opening. Sediment removal efficiency will be related to particle size distribution in the stormwater.

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Treatment Process and Description

Stormwater is collected at interception point(s) on the site and diverted to an untreated stormwater sediment pond or tank for removal of large sediment, and storage of the stormwater before it is treated by the filtration system. In a rapid filtration system, the untreated stormwater is pumped from the pond or tank through the filtration media. Slow filtration systems are designed using gravity to convey water from the pond or tank to and through the filtration media.

Sizing

Filtration treatment systems must be designed to control the velocity and peak volumetric flow rate that is discharged from the system and consequently the project site. See Element 3: Control Flow Rates for further details on this requirement.

The untreated stormwater storage pond or tank should be sized to hold 1.5 times the volume of runoff generated from the site during the 10-year, 24-hour storm event, minus the filtration treatment system flowrate for an 8-hour period. For a chitosan-enhanced sand filtration system, the filtration treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft^2. Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the filtration treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in III-2.3 Single Event Hydrograph Method. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

If the filtration treatment system design does not allow you to discharge at the rates as required by Element 3: Control Flow Rates, and if the site has a permanent Flow Control BMP that will serve the planned development, the discharge from the filtration treatment system may be directed to the permanent Flow Control BMP to comply with Element 3: Control Flow Rates. In this case, all discharge (including water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent Flow Control BMP. If site constraints make locating the untreated stormwater storage pond difficult, the permanent Flow Control BMP may be divided to serve as the untreated stormwater storage pond and the post-treatment temporary flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The designer must document in the Construction SWPPP how the permanent Flow Control BMP is able to attenuate the discharge from the site to meet the requirements of Element 3: Control Flow Rates. If the design of the permanent Flow Control BMP was modified for temporary construction flow control purposes, the construction of the permanent Flow Control BMP must be finalized, as designed for its permanent function, at project completion.

Maintenance Standards

- Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the untreated stormwater stored in the holding pond or tank, backwash return to the untreated stormwater pond or tank may be appropriate. However, other means of treatment and disposal may be necessary.
- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Sediment shall be removed from the storage and/or treatment ponds as necessary. Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds.
- Disposal of filtration equipment must comply with applicable local, state, and federal regulations.

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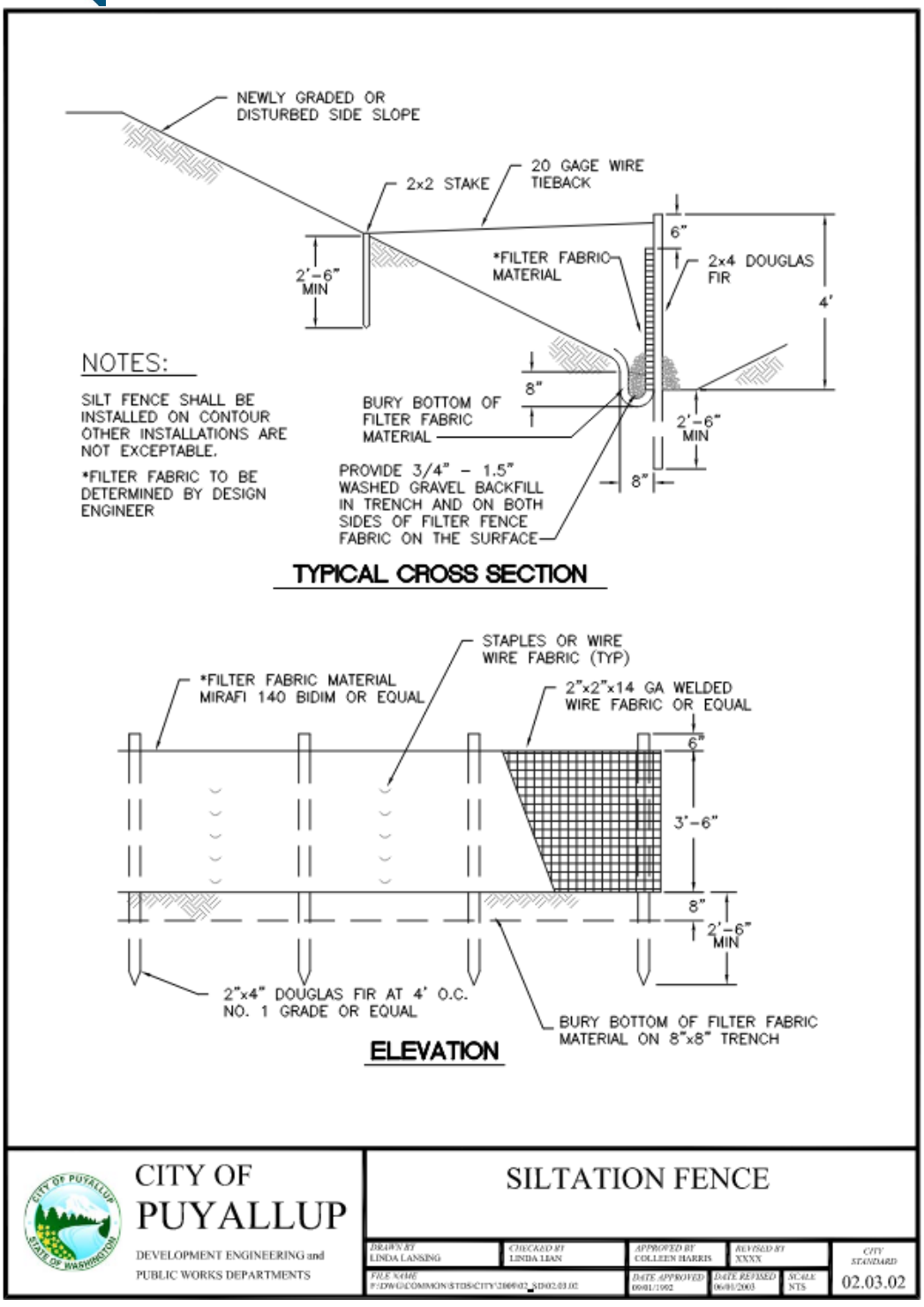
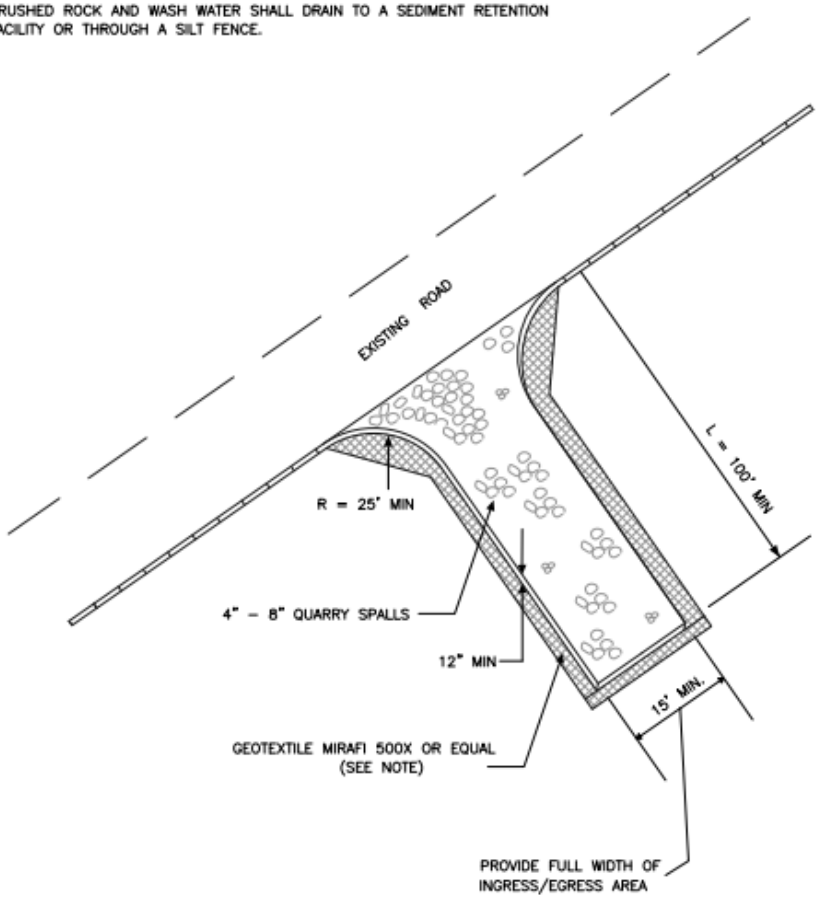
Appendix G: City of Puyallup Standard Details


NEWLY GRADED OR DISTURBED SIDE SLOPE
2x2 STAKE
20 GAGE WIRE TIEBACK
6"
2'-6" MIN
*FILTER FABRIC MATERIAL
2x4 DOUGLAS FIR
4'
NOTES:
SILT FENCE SHALL BE INSTALLED ON CONTOUR OTHER INSTALLATIONS ARE NOT EXCEPTABLE.
*FILTER FABRIC TO BE DETERMINED BY DESIGN ENGINEER
8"
BURY BOTTOM OF FILTER FABRIC MATERIAL
2'-6" MIN
PROVIDE 3/4" - 1.5" WASHED GRAVEL BACKFILL IN TRENCH AND ON BOTH SIDES OF FILTER FENCE FABRIC ON THE SURFACE
8"
TYPICAL CROSS SECTION
STAPLES OR WIRE WIRE FABRIC (TYP)
*FILTER FABRIC MATERIAL MIRAFI 140 BIDIM OR EQUAL
2"x2"x14 GA WELDED WIRE FABRIC OR EQUAL
6"
3'-6"
8"
2'-6" MIN
2"x4" DOUGLAS FIR AT 4' O.C. NO. 1 GRADE OR EQUAL
BURY BOTTOM OF FILTER FABRIC MATERIAL ON 8"x8" TRENCH
ELEVATION
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING and PUBLIC WORKS DEPARTMENTS
SILTATION FENCE
DRAWN BY LINDA LANSING
CHECKED BY LINDA LEAN
APPROVED BY COLLEEN HARRIS
REVISED BY XXXX
CITY STANDARD 02.03.02
FILE NAME P:\DWG\COMMON\STDS\CITY\2006\02_SD02.03.02
DATE APPROVED 09/01/1992
DATE REVISED 06/01/2003
SCALE NTS

NOTE:

1. GEOTEXTILE MIRAFI 500 X OR APPROVED EQUAL SHALL BE PLACED UNDER THE ENTIRETY OF THE TEMPORARY ENTRANCE.
2. ADDITIONAL ROCK SHALL BE ADDED PERIODICALLY TO MAINTAIN PROPER FUNCTION OF THE PAD.
3. IF THE PAD DOES NOT ADEQUATELY REMOVE THE MUD FROM THE VEHICLE'S WHEELS, THE WHEELS SHALL BE HOSED OFF BEFORE THE VEHICLE ENTERS A PAVED STREET. THE WASHING SHALL BE DONE ON AN AREA COVERED WITH CRUSHED ROCK AND WASH WATER SHALL DRAIN TO A SEDIMENT RETENTION FACILITY OR THROUGH A SILT FENCE.



CITY OF PUYALLUP
DEVELOPMENT ENGINEERING and PUBLIC WORKS DEPARTMENTS

TEMPORARY CONSTRUCTION ENTRANCE

DRAWN BY	CHECKED BY	APPROVED BY	REVISED BY	CITY STANDARD
JIM ERWIN-SVOBODA	LINDA LIAN	COLLEEN HARRIS	XXXX	05.01.01

FILE NAME	DATE APPROVED	DATE REVISED	SCALE
F:\DWG\COMMON\STDS\CITY\2009\05_GRD\05.01\05.01.01	07/01/2009	XX/XX/XX	1:40

1. ALL LIMITS OF CLEARING AND AREAS OF VEGETATION PRESERVATION AS PRESCRIBED ON THE PLANS SHALL BE CLEARLY FLAGGED IN THE FIELD AND OBSERVED DURING CONSTRUCTION.

2. ALL REQUIRED SEDIMENTATION AND EROSION CONTROL FACILITIES MUST BE CONSTRUCTED AND IN OPERATION PRIOR TO ANY LAND CLEARING AND/OR OTHER CONSTRUCTION TO ENSURE THAT SEDIMENT LADEN WATER DOES NOT ENTER THE NATURAL DRAINAGE SYSTEM. THE CONTRACTOR SHALL SCHEDULE AN INSPECTION OF THE EROSION CONTROL FACILITIES PRIOR TO ANY LAND CLEARING AND/OR CONSTRUCTION. ALL EROSION AND SEDIMENT FACILITIES SHALL BE MAINTAINED IN A SATISFACTORY CONDITION AS DETERMINED BY THE CITY, UNTIL SUCH TIME THAT CLEARING AND/OR CONSTRUCTION IS COMPLETED AND THE POTENTIAL FOR ON-SITE EROSION HAS PASSED. THE IMPLEMENTATION, MAINTENANCE, REPLACEMENT, AND ADDITIONS TO THE EROSION AND SEDIMENTATION CONTROL SYSTEMS SHALL BE THE RESPONSIBILITY OF THE PERMITEE.

3. THE EROSION AND SEDIMENTATION CONTROL SYSTEM FACILITIES DEPICTED ON THESE PLANS ARE INTENDED TO BE MINIMUM REQUIREMENTS TO MEET ANTICIPATED SITE CONDITIONS. AS CONSTRUCTION PROGRESSES AND UNEXPECTED OR SEASONAL CONDITIONS DICTATE, FACILITIES WILL BE NECESSARY TO ENSURE COMPLETE SILTATION CONTROL ON THE SITE. DURING THE COURSE OF CONSTRUCTION, IT SHALL BE THE OBLIGATION AND RESPONSIBILITY OF THE PERMITEE TO ADDRESS ANY NEW CONDITIONS THAT MAY BE CREATED BY HIS ACTIVITIES AND TO PROVIDE ADDITIONAL FACILITIES, OVER AND ABOVE THE MINIMUM REQUIREMENTS, AS MAY BE NEEDED TO PROTECT ADJACENT PROPERTIES, SENSITIVE AREAS, NATURAL WATER COURSES, AND/OR STORM DRAINAGE SYSTEMS.

4. APPROVAL OF THESE PLANS IS FOR GRADING, TEMPORARY DRAINAGE, EROSION AND SEDIMENTATION CONTROL ONLY. IT DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT STORM DRAINAGE DESIGN, SIZE OR LOCATION OF PIPES, RESTRICTORS, CHANNELS, OR RETENTION FACILITIES.

5. ANY DISTURBED AREA WHICH HAS BEEN STRIPPED OF VEGETATION AND WHERE NO FURTHER WORK IS ANTICIPATED FOR A PERIOD OF 30 DAYS OR MORE, MUST BE IMMEDIATELY STABILIZED WITH MULCHING, GRASS PLANTING, OR OTHER APPROVED EROSION CONTROL TREATMENT APPLICABLE TO THE TIME OF YEAR IN QUESTION. GRASS SEEDING ALONE WILL BE ACCEPTABLE ONLY DURING THE MONTHS OF APRIL THROUGH SEPTEMBER INCLUSVE. SEEDING MAY PROCEED OUTSIDE THE SPECIFIED TIME PERIOD WHENEVER IT IS IN THE INTEREST OF THE PERMITEE BUT MUST BE AUGMENTED WITH MULCHING, NETTING, OR OTHER TREATMENT APPROVED BY THE CITY.

6. IN CASE EROSION OR SEDIMENTATION OCCURS TO ADJACENT PROPERTIES, ALL CONSTRUCTION WORK WITHIN THE DEVELOPMENT THAT WILL FURTHER AGGRAVATE THE SITUATION MUST CEASE, AND THE OWNER/CONTRACTOR WILL IMMEDIATELY COMMENCE RESTORATION METHODS. RESTORATION ACTIVITY WILL CONTINUE UNTIL SUCH TIME AS THE AFFECTED PROPERTY OWNER IS SATISFIED.

7. NO TEMPORARY OR PERMANENT STOCKPILING OF MATERIALS OR EQUIPMENT SHALL OCCUR WITHIN CRITICAL AREAS OR ASSOCIATED BUFFERS, OR THE CRITICAL ROOT ZONE FOR VEGETATION PROPOSED FOR RETENTION.

CITY OF PUYALLUP
DEVELOPMENT ENGINEERING and PUBLIC WORKS DEPARTMENTS

GRADING, EROSION, AND SEDIMENTATION CONTROL NOTES

DRAWN BY	CHECKED BY	APPROVED BY	REVISED BY	CITY STANDARD
JIM ERWIN-SVOBODA	LINDA LIAN	COLLEEN HARRIS	LINDA LIAN	05.02.01
FILE NAME: P:\DWG\COMMON STDS\CITY 2009\05_GRD\05.01\05.02.01		DATE APPROVED: 07/01/2009	DATE REVISED: 11/18/2014	SCALE: NT

202 East 34th Street
Tacoma, WA 98404

Appendix H: Construction Site Inspection Report

Construction Stormwater Site Inspection Form

Project Name _____ Permit # _____ Inspection Date _____ Time _____

Name of Certified Erosion Sediment Control Lead (CESCL) or qualified inspector if *less than one acre*
Print Name: _____

Approximate rainfall amount since the last inspection (in inches): _____

Approximate rainfall amount in the last 24 hours (in inches): _____

Current Weather Clear ☐ Cloudy ☐ Mist ☐ Rain ☐ Wind ☐ Fog ☐

A. Type of inspection: Weekly ☐ Post Storm Event ☐ Other ☐

B. Phase of Active Construction (*check all that apply*):

Pre Construction/installation of erosion/sediment controls	☐	Clearing/Demo/Grading	☐	Infrastructure/storm/roads	☐
Concrete pours	☐	Vertical Construction/buildings	☐	Utilities	☐
Offsite improvements	☐	Site temporary stabilized	☐	Final stabilization	☐

C. Questions:

1. Were all areas of construction and discharge points inspected? Yes ___ No ___
2. Did you observe the presence of suspended sediment, turbidity, discoloration, or oil sheen Yes ___ No ___
3. Was a water quality sample taken during inspection? (*refer to permit conditions S4 & S5*) Yes ___ No ___
4. Was there a turbid discharge 250 NTU or greater, or Transparency 6 cm or less?* Yes ___ No ___
5. If yes to #4 was it reported to Ecology? Yes ___ No ___
6. Is pH sampling required? pH range required is 6.5 to 8.5. Yes ___ No ___

If answering yes to a discharge, describe the event. Include when, where, and why it happened; what action was taken, and when.

_____

_____

_____

_____

*If answering yes to # 4 record NTU/Transparency with continual sampling daily until turbidity is 25 NTU or less/ transparency is 33 cm or greater.

Sampling Results: Date: _____

Parameter	Method (circle one)	Result			Other/Note
		NTU	cm	pH	
Turbidity	tube, meter, laboratory				
pH	Paper, kit, meter				

Construction Stormwater Site Inspection Form

D. Check the observed status of all items. Provide "Action Required "details and dates.

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
1 Clearing Limits	Before beginning land disturbing activities are all clearing limits, natural resource areas (streams, wetlands, buffers, trees) protected with barriers or similar BMPs? (high visibility recommended)						
2 Construction Access	Construction access is stabilized with quarry spalls or equivalent BMP to prevent sediment from being tracked onto roads?						
	Sediment tracked onto the road way was cleaned thoroughly at the end of the day or more frequent as necessary.						
3 Control Flow Rates	Are flow control measures installed to control stormwater volumes and velocity during construction and do they protect downstream properties and waterways from erosion?						
	If permanent infiltration ponds are used for flow control during construction, are they protected from siltation?						
4 Sediment Controls	All perimeter sediment controls (e.g. silt fence, wattles, compost socks, berms, etc.) installed, and maintained in accordance with the Stormwater Pollution Prevention Plan (SWPPP).						
	Sediment control BMPs (sediment ponds, traps, filters etc.) have been constructed and functional as the first step of grading.						
	Stormwater runoff from disturbed areas is directed to sediment removal BMP.						
5 Stabilize Soils	Have exposed un-worked soils been stabilized with effective BMP to prevent erosion and sediment deposition?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
5 Stabilize Soils Cont.	Are stockpiles stabilized from erosion, protected with sediment trapping measures and located away from drain inlet, waterways, and drainage channels?						
	Have soils been stabilized at the end of the shift, before a holiday or weekend if needed based on the weather forecast?						
6 Protect Slopes	Has stormwater and ground water been diverted away from slopes and disturbed areas with interceptor dikes, pipes and or swales?						
	Is off-site storm water managed separately from stormwater generated on the site?						
	Is excavated material placed on uphill side of trenches consistent with safety and space considerations?						
	Have check dams been placed at regular intervals within constructed channels that are cut down a slope?						
7 Drain Inlets	Storm drain inlets made operable during construction are protected.						
	Are existing storm drains within the influence of the project protected?						
8 Stabilize Channel and Outlets	Have all on-site conveyance channels been designed, constructed and stabilized to prevent erosion from expected peak flows?						
	Is stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream conveyance systems?						
9 Control Pollutants	Are waste materials and demolition debris handled and disposed of to prevent contamination of stormwater?						
	Has cover been provided for all chemicals, liquid products, petroleum products, and other material?						
	Has secondary containment been provided capable of containing 110% of the volume?						
	Were contaminated surfaces cleaned immediately after a spill incident?						
	Were BMPs used to prevent contamination of stormwater by a pH modifying sources?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
9 Cont.	Wheel wash wastewater is handled and disposed of properly.						
10 Control Dewatering	Concrete washout in designated areas. No washout or excess concrete on the ground.						
	Dewatering has been done to an approved source and in compliance with the SWPPP.						
	Were there any clean non turbid dewatering discharges?						
11 Maintain BMP	Are all temporary and permanent erosion and sediment control BMPs maintained to perform as intended?						
12 Manage the Project	Has the project been phased to the maximum degree practicable?						
	Has regular inspection, monitoring and maintenance been performed as required by the permit?						
	Has the SWPPP been updated, implemented and records maintained?						
13 Protect LID	Is all Bioretention and Rain Garden Facilities protected from sedimentation with appropriate BMPs?						
	Is the Bioretention and Rain Garden protected against over compaction of construction equipment and foot traffic to retain its infiltration capabilities?						
	Permeable pavements are clean and free of sediment and sediment laden-water runoff. Muddy construction equipment has not been on the base material or pavement.						
	Have soiled permeable pavements been cleaned of sediments and pass infiltration test as required by stormwater manual methodology?						
	Heavy equipment has been kept off existing soils under LID facilities to retain infiltration rate.						

E. Check all areas that have been inspected. ✔

All in place BMPs ☐ All disturbed soils ☐ All concrete wash out area ☐ All material storage areas ☐
All discharge locations ☐ All equipment storage areas ☐ All construction entrances/exits ☐

F. Elements checked "Action Required" (section D) describe corrective action to be taken. List the element number; be specific on location and work needed. Document, initial, and date when the corrective action has been completed and inspected.

Element #	Description and Location	Action Required	Completion Date	Initials

Attach additional page if needed

Sign the following certification:

"I certify that this report is true, accurate, and complete, to the best of my knowledge and belief"

Inspected by: (print) _____ (Signature) _____ Date: _____

Title/Qualification of Inspector: _____

202 East 34th Street
Tacoma, WA 98404

Appendix I: RTank Details

R-TANK SUBSURFACE STORAGE SYSTEM
BUOYANCY CALCULATION

ACF WEST INC. GEOSYNTHETICS
Products | Service | Solutions

PROJECT INFORMATION	
Project Name	East Town Crossing
City/County	Puyallup
State	WA
Project #	23-004WA
Date	7/28/2023
Calculated By	JDV
Site Designation	R-Tank 1

STATIC PARAMETERS	
Soil Density (unsaturated)	100.00 lbs/cf
Stone Density	140.00 lbs/cf
Water Density	62.40 lbs/cf

R-TANK INPUT PARAMETERS	
Lowest Surface Elevation	73.36
Ground Water Elevation	71.00
R-Tank Module	SD Triple
Number of R-Tank Modules	5,919
Tank Invert Elevation	68.63
Top of Tank Elevation	70.86
R-Tank Module Height	2.23 ft
R-Tank Weight (modules only)	166,974.99 lbs
Liner Location	Excavation
Excavation Area	19,856.00 sf
Stone Base Depth	3.00 in
Stone Base Within Liner?	YES
Stone Cover Depth	12.00 in
Stone Cover Within Liner?	YES
Stone Volume	28463.76 cf
Stone Weight	3,984,925.85 lbs
Soil Cover Depth	1.50 ft
Soil Volume	29,767.45 cf
Soil Weight	2,976,745.33 lbs

RESULTS	
Buoyant Force	3,246,217.73 lbs
Downward Force	7,128,646.17 lbs
Safety Factor (Must be at least 1.25)	2.20
Is Design Acceptable?	YES

Notes:

1. It is the responsibility of the design engineer to evaluate and verify if these calculations are acceptable for the project. ACF West does not certify these results and are provided as a preliminary evaluation.
2. This calculator's indication of an acceptable design is purely to signify that a safety factor of 1.25 was achieved with the data provided.
3. These calculations assume that the system is devoid of water.
4. The weight of additional items like Maintenance Ports, fabric, and liner were not included in the downforce calculation.
5. Saturated soil was not factored into the soil weight when the groundwater is above the system.

R-TANK SUBSURFACE STORAGE SYSTEM
BUOYANCY CALCULATION

ACF WEST INC. GEOSYNTHETICS
Products | Service | Solutions

PROJECT INFORMATION	
Project Name	East Town Crossing
City/County	Puyallup
State	WA
Project #	23-004WA
Date	7/28/2023
Calculated By	JDV
Site Designation	R-Tank 2

STATIC PARAMETERS	
Soil Density (unsaturated)	100.00 lbs/cf
Stone Density	140.00 lbs/cf
Water Density	62.40 lbs/cf

R-TANK INPUT PARAMETERS	
Lowest Surface Elevation	74.80
Ground Water Elevation	71.00
R-Tank Module	SD Pent
Number of R-Tank Modules	6,178
Tank Invert Elevation	68.63
Top of Tank Elevation	72.30
R-Tank Module Height	3.67 ft
R-Tank Weight (modules only)	280,913.66 lbs
Liner Location	Excavation
Excavation Area	20,371.00 sf
Stone Base Depth	3.00 in
Stone Base Within Liner?	YES
Stone Cover Depth	12.00 in
Stone Cover Within Liner?	YES
Stone Volume	30424.70 cf
Stone Weight	4,259,457.99 lbs
Soil Cover Depth	1.50 ft
Soil Volume	30,471.62 cf
Soil Weight	3,047,162.08 lbs

RESULTS	
Buoyant Force	3,330,414.05 lbs
Downward Force	7,587,533.74 lbs
Safety Factor (Must be at least 1.25)	2.28
Is Design Acceptable?	YES

Notes:

1. It is the responsibility of the design engineer to evaluate and verify if these calculations are acceptable for the project. ACF West does not certify these results and are provided as a preliminary evaluation.
2. This calculator's indication of an acceptable design is purely to signify that a safety factor of 1.25 was achieved with the data provided.
3. These calculations assume that the system is devoid of water.
4. The weight of additional items like Maintenance Ports, fabric, and liner were not included in the downforce calculation.
5. Saturated soil was not factored into the soil weight when the groundwater is above the system.

R-TANK SUBSURFACE STORAGE SYSTEM
BUOYANCY CALCULATION

ACF WEST INC. GEOSYNTHETICS
Products | Service | Solutions

PROJECT INFORMATION	
Project Name	East Town Crossing
City/County	Puyallup
State	WA
Project #	23-004WA
Date	7/28/2023
Calculated By	JDV
Site Designation	R-Tank 3

STATIC PARAMETERS	
Soil Density (unsaturated)	100.00 lbs/cf
Stone Density	140.00 lbs/cf
Water Density	62.40 lbs/cf

R-TANK INPUT PARAMETERS	
Lowest Surface Elevation	75.87
Ground Water Elevation	71.00
R-Tank Module	HD Quad
Number of R-Tank Modules	3,359
Tank Invert Elevation	68.63
Top of Tank Elevation	74.21
R-Tank Module Height	5.58 ft
R-Tank Weight (modules only)	209,601.60 lbs
Liner Location	Excavation
Excavation Area	11,317.00 sf
Stone Base Depth	3.00 in
Stone Base Within Liner?	YES
Stone Cover Depth	12.00 in
Stone Cover Within Liner?	YES
Stone Volume	19592.82 cf
Stone Weight	2,742,994.50 lbs
Soil Cover Depth	0.66 ft
Soil Volume	7,497.51 cf
Soil Weight	749,751.25 lbs

RESULTS	
Buoyant Force	1,850,193.70 lbs
Downward Force	3,702,347.35 lbs
Safety Factor (Must be at least 1.25)	2.00
Is Design Acceptable?	YES

Notes:

1. It is the responsibility of the design engineer to evaluate and verify if these calculations are acceptable for the project. ACF West does not certify these results and are provided as a preliminary evaluation.
2. This calculator's indication of an acceptable design is purely to signify that a safety factor of 1.25 was achieved with the data provided.
3. These calculations assume that the system is devoid of water.
4. The weight of additional items like Maintenance Ports, fabric, and liner were not included in the downforce calculation.
5. Saturated soil was not factored into the soil weight when the groundwater is above the system.

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Tacoma, WA 98404

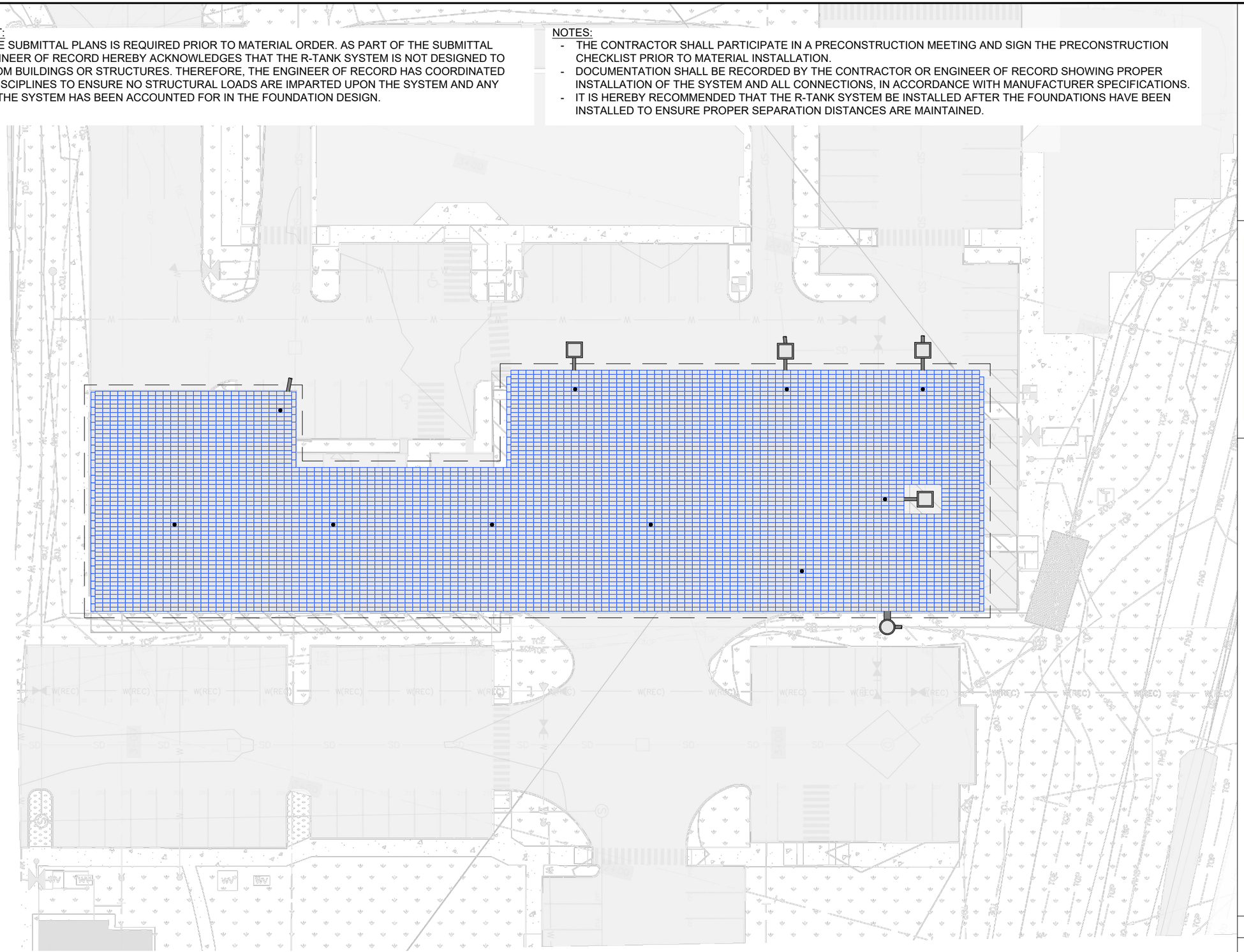
NOTE: IMPERMEABLE LINER WILL ADHERE TO Ecology Table V-1.6

Table V-1.6: Geotextile Strength Properties for Impermeable Liner Protection

Geotextile Property	Test Method	Geotextile Property Requirements[1]
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	250 lbs min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	> 50%
Seam Breaking Strength (if seams are present)	ASTM D4632 and ASTM D4884 (adapted for grab test)	220 lbs min.
Puncture Resistance	ASTM D4833	125 lbs min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	90 lbs min.
Ultraviolet (UV) Radiation	ASTM D4355	50% strength stability retained min., after 500 hrs. in xenon arc device
1. All geotextile properties are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the table).		

ACKNOWLEDGEMENT:
AN APPROVAL OF THE SUBMITTAL PLANS IS REQUIRED PRIOR TO MATERIAL ORDER. AS PART OF THE SUBMITTAL APPROVAL, THE ENGINEER OF RECORD HEREBY ACKNOWLEDGES THAT THE R-TANK SYSTEM IS NOT DESIGNED TO SUPPORT LOADS FROM BUILDINGS OR STRUCTURES. THEREFORE, THE ENGINEER OF RECORD HAS COORDINATED WITH THE PROPER DISCIPLINES TO ENSURE NO STRUCTURAL LOADS ARE IMPARTED UPON THE SYSTEM AND ANY INFILTRATION FROM THE SYSTEM HAS BEEN ACCOUNTED FOR IN THE FOUNDATION DESIGN.

NOTES:
- THE CONTRACTOR SHALL PARTICIPATE IN A PRECONSTRUCTION MEETING AND SIGN THE PRECONSTRUCTION CHECKLIST PRIOR TO MATERIAL INSTALLATION.
- DOCUMENTATION SHALL BE RECORDED BY THE CONTRACTOR OR ENGINEER OF RECORD SHOWING PROPER INSTALLATION OF THE SYSTEM AND ALL CONNECTIONS, IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS.
- IT IS HEREBY RECOMMENDED THAT THE R-TANK SYSTEM BE INSTALLED AFTER THE FOUNDATIONS HAVE BEEN INSTALLED TO ENSURE PROPER SEPARATION DISTANCES ARE MAINTAINED.



R-TANK^{SD} SYSTEM OVERLAY
SCALE: 1" = 30'

0 30' 60'
SCALE 1" = 30'

R-TANK

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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Products | Service | Solutions

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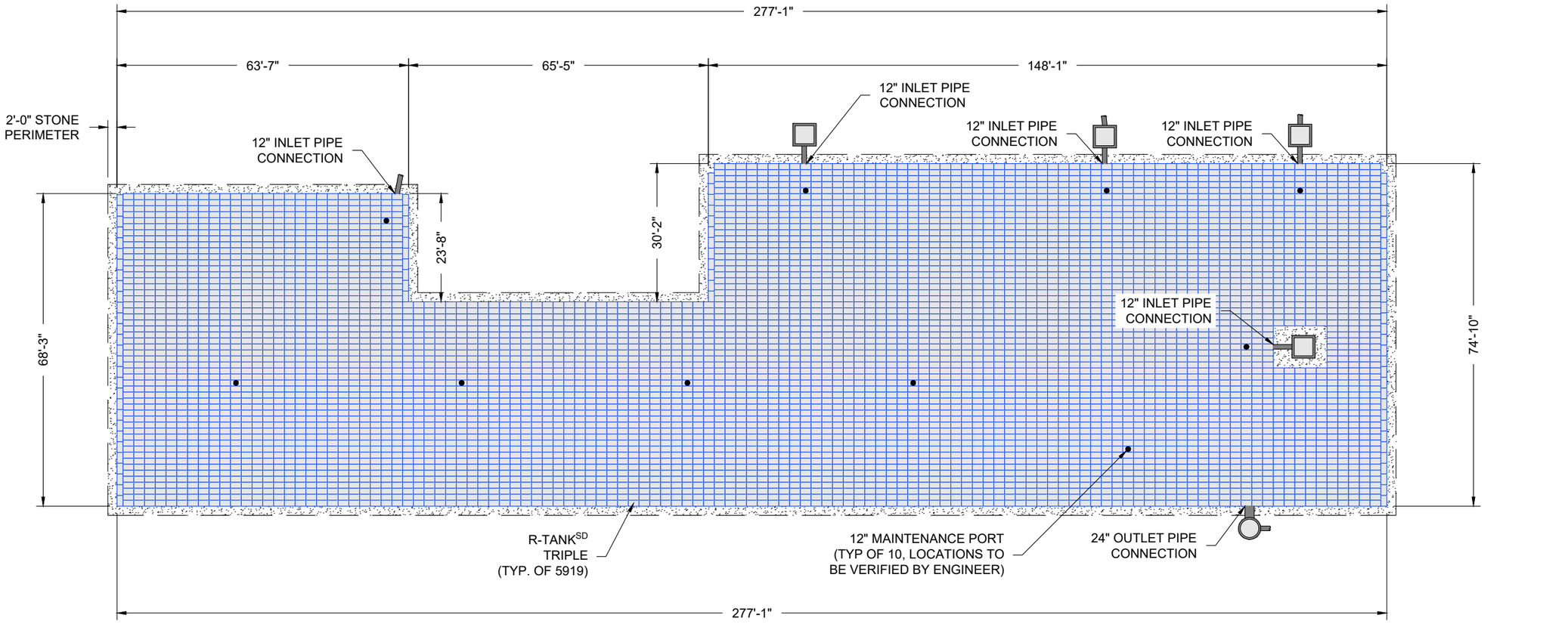
R-TANK^{SD} SYSTEM OVERLAY
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 1

DRAWN BY
EDQ
DATE
09/28/2023
ACF WEST PROJECT NUMBER
23-004WA
SHEET NO.
1 of 6

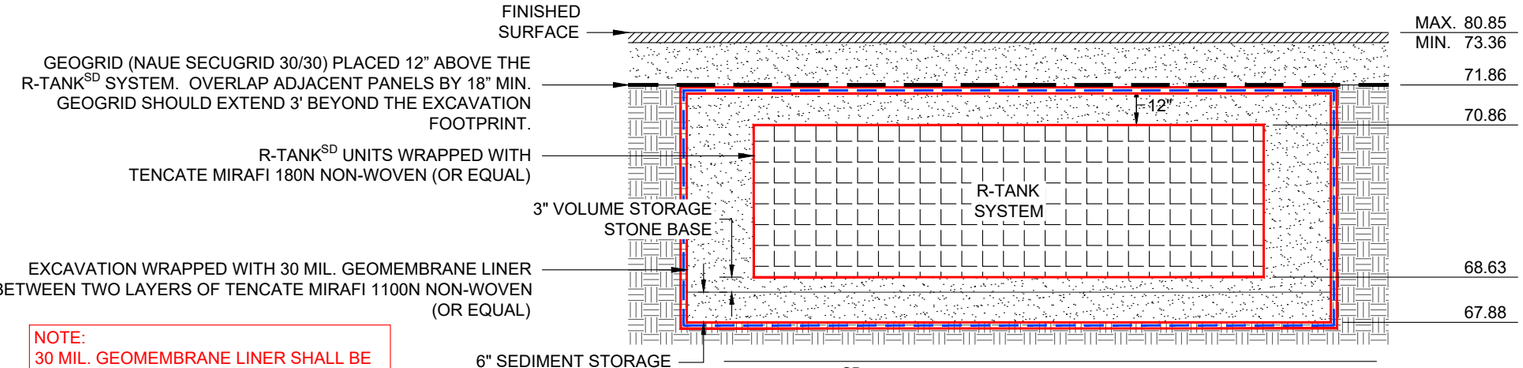
NOTE:
MINIMUM COVER FROM TOP OF TANK TO FINISH GRADE MUST BE AT LEAST 30" TO MEET A 45 KIP OUTRIGGER LOAD ON AN 18'X18" PAD.



NOTES:
1. DEAD STORAGE VOLUME FROM ELEVATION 67.88 TO 68.38 = 3,971 CF
2. LIVE STORAGE VOLUME FROM ELEVATION 68.38 TO 71.86 = 49,977 CF
3. ONLY 3" OF BASE STONE INCLUDED IN LIVE STORAGE VOLUME.

0 25' 50'
SCALE 1" = 25'

LAYOUT SCALE	1" = 25'
R-TANK^SD MODULE TYPE	TRIPLE
TRAFFIC LOAD	45 KIP OUTRIGGER (18"X18")
# OF TRIPLE R-TANKS	5,919
TOTAL SYSTEM STORAGE	49,977 CF
R-TANK STORAGE VOLUME	38,592 CF
STONE STORAGE VOLUME (40% VOID RATIO)	11,385 CF
TOP OF COVER STONE ELEV. (12")	71.86
NAUE SECUGRID 30/30 GEOGRID ELEV.	71.86
TOP OF R-TANK ELEV.	70.86
TANK INVERT	68.63
INVERT OF STONE BASE (9")	67.88
MIN. STONE PERIMETER WIDTH	2.0 FT
SEE SHEETS 3 - 6 FOR DETAILS AND ADDITIONAL INFORMATION	



NOTE:
30 MIL. GEOMEMBRANE LINER SHALL BE ULTRAVIOLET (UV) LIGHT RESISTANT.

R-TANK^SD TANK WRAP & EXCAVATION ENVELOPE DETAIL

SD R-TANK

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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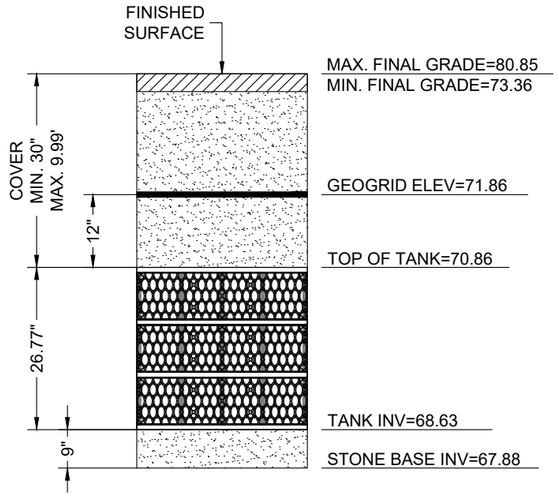
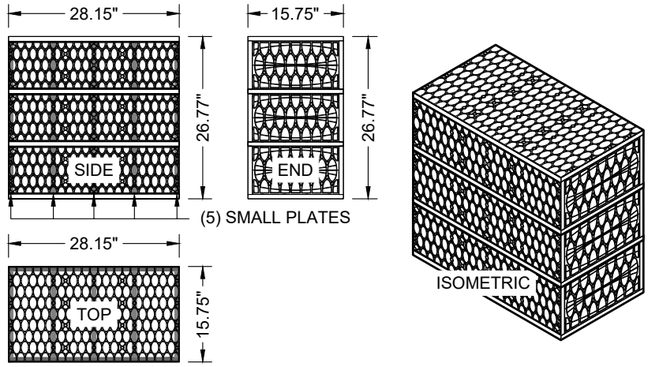
R-TANK^SD SYSTEM LAYOUT
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 1

DRAWN BY
EDQ
DATE
09/28/2023
ACF WEST PROJECT NUMBER
23-004WA
SHEET NO.
2 of 6



TRIPLE R-TANK^{SD} - ELEVATION



TRIPLE R-TANK^{SD} - MODULE DETAIL

MODULE DATA

GEOMETRY:
LENGTH = 28.15 IN. (715 MM)
WIDTH = 15.75 IN. (400 MM)
HEIGHT = 26.77 IN. (680 MM)
TANK VOLUME = 6.87 CF
STORAGE VOLUME = 6.52 CF
VOID INTERNAL VOLUME: 95%
VOID SURFACE AREA: 90%

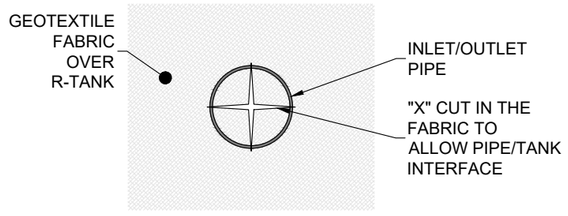
LOAD RATING:
42.9 PSI, (MODULE ONLY)
HS20/HS25 - SEE SPEC FOR COVER REQUIREMENTS
MATERIAL:
100% RECYCLED POLYPROPYLENE
SMALL PLATES REQUIRED:
5/SEGMENT, 15/MODULE

R-TANK^{SD} QUANTITIES	
R-TANK^{SD} MODULE TYPE	TRIPLE
# OF TRIPLE R-TANKS	5,919
TOTAL SYSTEM STORAGE	49,977 CF
R-TANK STORAGE VOLUME	38,592 CF
STONE STORAGE VOLUME (40% VOID RATIO)	11,385 CF
STONE BED FOOTPRINT	19,856 SF
STONE QUANTITY	1,422 CY
TENCATE MIRAFI 180N NON-WOVEN TANK WRAP	43,950 SF (4,883 SY)
30 MIL. GEOMEMBRANE LINER EXCAVATION WRAP	49,184 SF (5,465 SY)
TENCATE MIRAFI 1100N NON-WOVEN LINER PROTECTION	98,368 SF (10,930 SY)
NAUE SECUGRID 30/30 GEOGRID	25,522 SF (2,836 SY)
12" MAINTENANCE PORTS	10
12" PIPE BOOTS	5
24" PIPE BOOTS	1
TRASHGUARD PLUS UNITS (RECOMMENDED)	5
NOTE: STONE QUANTITY INCLUDES 12" OF COVER AND 9" OF BASE.	
NOTE: GEOTEXTILE / LINER QUANTITIES INCLUDE A 15% WASTE FACTOR.	

NOTE:
30 MIL. GEOMEMBRANE LINER SHALL BE ULTRAVIOLET (UV) LIGHT RESISTANT.

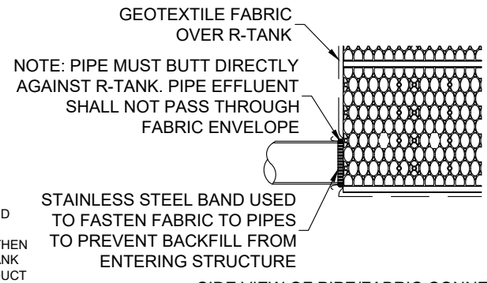
NOTES:
1. DEAD STORAGE VOLUME FROM ELEVATION 67.88 TO 68.38 = 3,971 CF
2. LIVE STORAGE VOLUME FROM ELEVATION 68.38 TO 71.86 = 49,977 CF
3. ONLY 3" OF BASE STONE INCLUDED IN LIVE STORAGE VOLUME.

CUT AN "X" IN THE FABRIC ENVELOPE THAT IS SLIGHTLY LARGER THAN THE PIPE. PULL THE FABRIC FLAPS AROUND THE PIPE, AND SEAL WITH A STAINLESS STEEL BAND.

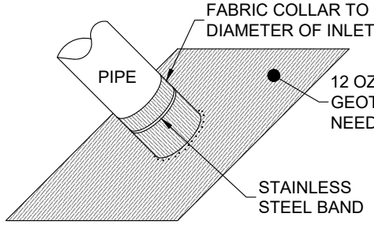


END VIEW OF PIPE/FABRIC CONNECTION

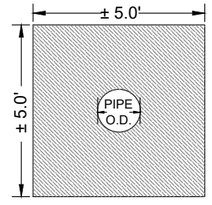
AFTER TANK WRAP IS SECURED TO PIPE, SLIDE BOOT AGAINST R-TANK AND SECURE WITH SECOND STAINLESS STEEL BAND, THEN ATTACH BOOT FLAP TO TANK ENVELOPE FABRIC WITH DUCT TAPE OR OTHER ADHESIVE.



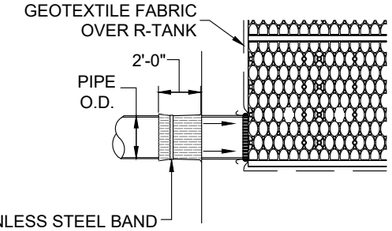
SIDE VIEW OF PIPE/FABRIC CONNECTION



GEOTEXTILE BOOT



FRONT VIEW OF GEOTEXTILE BOOT



SIDE VIEW OF GEOTEXTILE BOOT

R-TANK^{SD} TYPICAL TANK INLET/OUTLET W/ GEOTEXTILE PIPE BOOT DETAIL

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

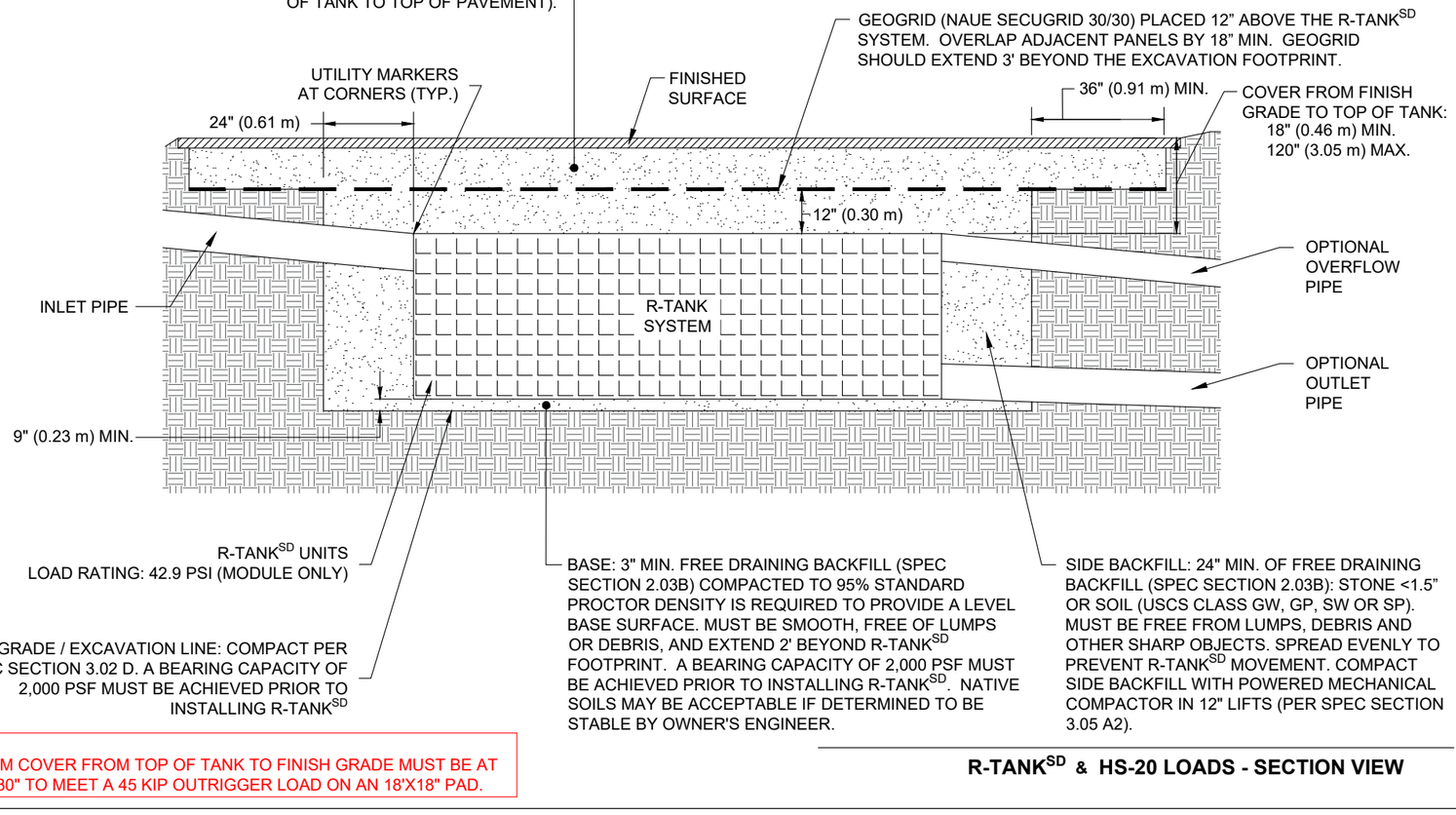
FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^{SD} SYSTEM DETAILS
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 1

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA

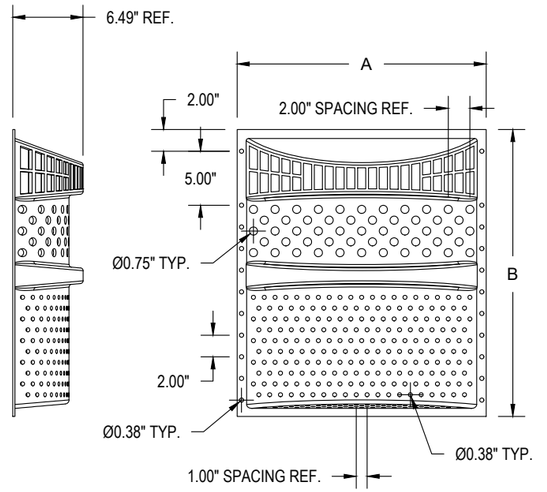
TOTAL COVER: 18" MINIMUM AND 120" MAXIMUM. FIRST 12" MUST BE FREE DRAINING BACKFILL (SPEC SECTION 2.03B): STONE <1.5" OR SOIL (USCS CLASS GW, GP, SW OR SP). ADDITIONAL FILL MAY BE STRUCTURAL FILL (SPEC SECTION 2.03C): STONE OR SOIL (USCS CLASS SM, SP, SW, GM, GP OR GW) WITH MAX CLAY CONTENT<10%, MAX 25% PASSING NO. 200 SIEVE, AND MAX PLASTICITY INDEX OF 4. A MIN. 12" COVER MUST BE MAINTAINED BETWEEN BACKFILL EQUIPMENT AND THE TOP OF THE R-TANK™ SYSTEM AT ALL TIMES. TOTAL HEIGHT OF TOP BACKFILL SHOULD NOT EXCEED 10'. CONTACT ACF WEST IF MORE THAN 10' OR LESS THAN 18" OF TOP BACKFILL IS REQUIRED (FROM TOP OF TANK TO TOP OF PAVEMENT).

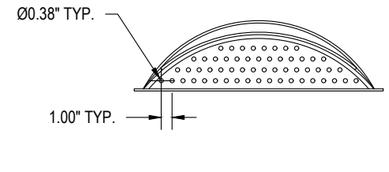
NOTES:
1. FOR COMPLETE MODULE DATA, SEE APPROPRIATE R-TANK^{SD} MODULE SHEET .
2. INSTALLATIONS PER THIS DETAIL MEET GUIDELINES OF HL-93 LOADING PER THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, CUSTOMARY U.S. UNITS, 7TH EDITION, 2014 WITH 2015 AND 2016 INTERIM REVISIONS.
3. PRE-TREATMENT STRUCTURES NOT SHOWN.
4. FOR INFILTRATION APPLICATIONS, GEOTEXTILE ENVELOPING R-TANK SHALL BE TENCATE MIRAFI FW-402 WOVEN (PER SPEC SECTION 2.02A) AND BASE SHALL BE 4" MIN. UNCOMPACTED FREE DRAINING BACKFILL (SPEC SECTION 2.03A) TO PROVIDE A LEVEL BASE. SURFACE MUST BE SMOOTH, FREE OF LUMPS OR DEBRIS, AND EXTEND 2' BEYOND R-TANK^{SD} FOOTPRINT.



NOTE:
MINIMUM COVER FROM TOP OF TANK TO FINISH GRADE MUST BE AT LEAST 30" TO MEET A 45 KIP OUTRIGGER LOAD ON AN 18'X18" PAD.

R-TANK^{SD} & HS-20 LOADS - SECTION VIEW





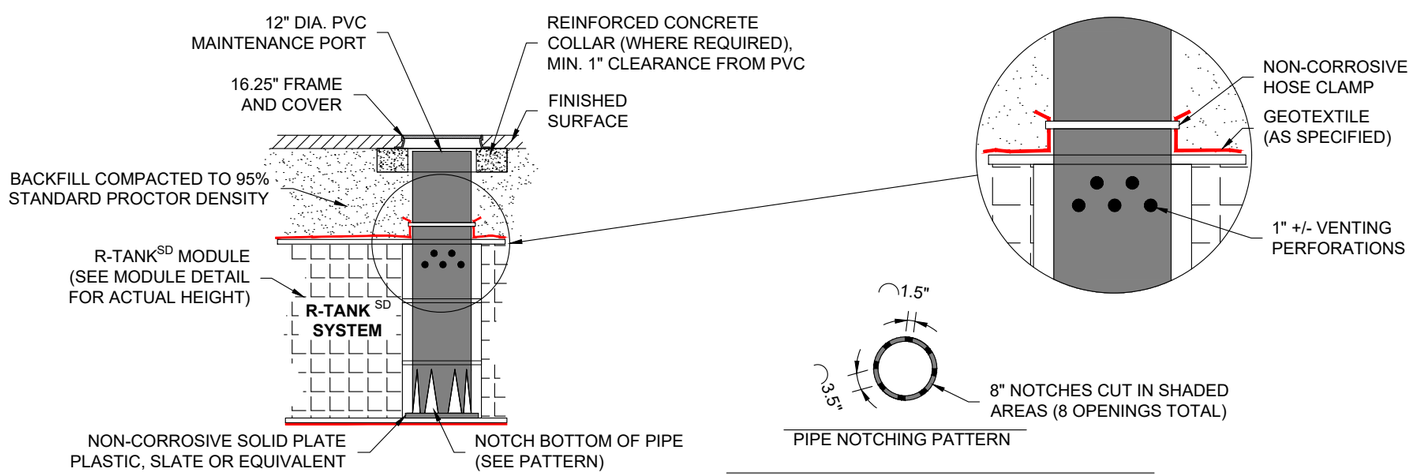
SIZE	A	B
23" x 24"	23"	26.51"
28" x 30"	28"	33.15"
34" x 36"	34"	38.69"

±0.25" TOLERANCE ON DIMENSIONS

NOTE:
TRASHGUARD PLUS UNITS ARE RECOMMENDED TO BE INSTALLED IN ALL CATCH BASINS DIRECTLY CONNECTED UPSTREAM OF THE R-TANK SYSTEM.

TRASHGUARD PLUS PRETREATMENT DETAIL

NOTES
1. THIS PORT IS USED TO PUMP WATER INTO THE SYSTEM AND RE-SUSPEND ACCUMULATED SEDIMENT SO THAT IT MAY BE PUMPED OUT.
2. MINIMUM REQUIRED MAINTENANCE INCLUDES A QUARTERLY INSPECTION DURING THE FIRST YEAR OF OPERATION AND A YEARLY INSPECTION THEREAFTER. FLUSH AS NEEDED.
3. R-TANK^{HD}, R-TANK^{SD}, R-TANK^{UD} AND R-TANK^{XD} MAY BE USED IN TRAFFIC APPLICATIONS.
4. SEE TRAFFIC LOADING DETAIL FOR MINIMUM & MAXIMUM COVER REQUIREMENTS.
5. IF MAINTENANCE PORT IS LOCATED IN A NON-TRAFFIC AREA, A PLASTIC CAP CAN BE USED IN LIEU OF A FRAME AND COVER WITH CONCRETE COLLAR.



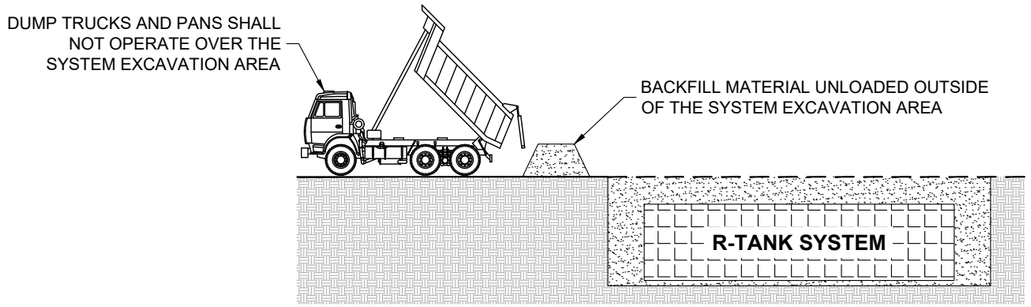
R-TANK^{SD} TYPICAL MAINTENANCE PORT

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^{SD} SYSTEM DETAILS
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 1

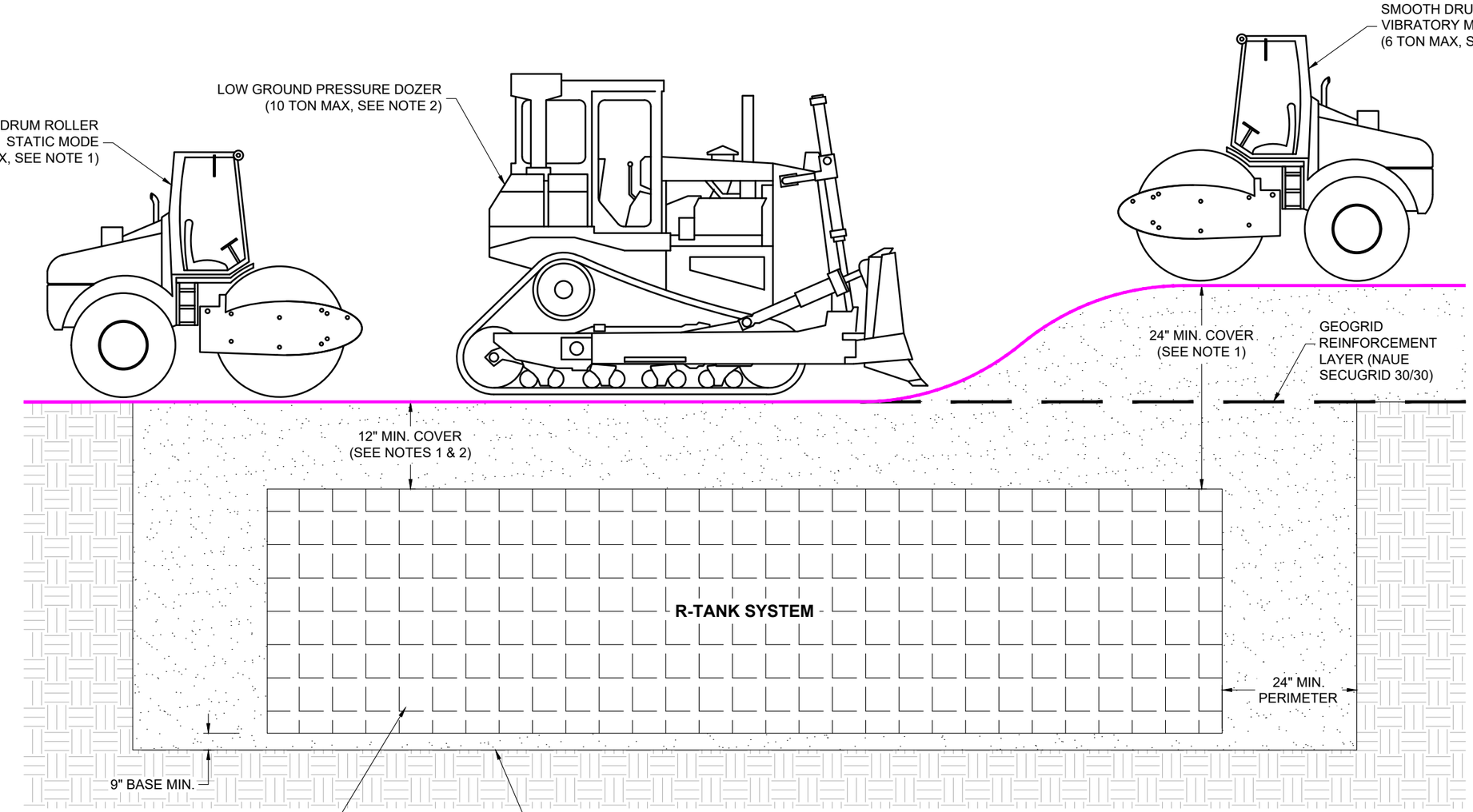
DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA



DUMP TRUCK DETAIL (SEE NOTE 3)

NOTES:

1. FOLLOWING PLACEMENT OF SIDE BACKFILL, A UNIFORM 12" LIFT OF THE FREELY DRAINING MATERIAL (SPEC SECTION 2.03 B2) SHALL BE PLACED OVER THE R-TANK AND LIGHTLY COMPACTED USING A WALK-BEHIND TRENCH ROLLER. ALTERNATELY, A ROLLER (MAXIMUM GROSS VEHICLE WEIGHT OF 6 TONS) MAY BE USED. ROLLER MUST REMAIN IN STATIC MODE UNTIL A MINIMUM OF 24" OF COVER HAS BEEN PLACED OVER THE MODULES. SHEEP FOOT ROLLERS SHOULD NOT BE USED. **SPEC SECTION 3.05 A5**
2. ONLY LOW PRESSURE TIRE OR TRACK VEHICLES (LESS THAN 7 PSI AND OPERATING WEIGHT OF LESS THAN 20,000 LBS) SHALL BE OPERATED OVER THE R-TANK SYSTEM DURING CONSTRUCTION. **SPEC SECTION 3.05 A5**
3. DUMP TRUCKS AND PANS SHALL NOT BE OPERATED WITHIN THE R-TANK SYSTEM AT ANY TIME. WHERE NECESSARY, THE HEAVY EQUIPMENT SHOULD UNLOAD IN AN AREA ADJACENT TO THE R-TANK SYSTEM AND THE MATERIAL SHOULD BE MOVED OVER THE SYSTEM WITH TRACKED EQUIPMENT. **SPEC SECTION 3.05 A5**
4. ENSURE THAT ALL UNRELATED CONSTRUCTION TRAFFIC IS KEPT AWAY FROM THE LIMITS OF EXCAVATION UNTIL THE PROJECT IS COMPLETE AND FINAL SURFACE MATERIALS ARE IN PLACE. NO NON-INSTALLATION RELATED LOADING SHOULD BE ALLOWED OVER THE R-TANK SYSTEM UNTIL THE FINAL DESIGN SECTION HAS BEEN CONSTRUCTED (INCLUDING PAVEMENT). **SPEC SECTION 3.05 B**
5. SEE R-TANK INSTALLATION GUIDE OR CONTACT YOUR LOCAL ACF WEST REPRESENTATIVE FOR ADDITIONAL INFORMATION.



CONSTRUCTION EQUIPMENT COVER DETAIL - VEHICULAR TRAFFIC

R-TANK

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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R-TANK^SD CONSTRUCTION EQUIPMENT COVER DETAIL
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 1

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA
SHEET NO.: 5 of 6

R-TANK SPECIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, technical specification and general provisions of the Contract as modified herein apply to this section.

1.02 DESCRIPTION OF WORK INCLUDED

A. Provide excavation and base preparation per geotechnical engineer's recommendations and/or as shown on the design drawings, to provide adequate support for project design loads and safety from excavation sidewall collapse. Excavations shall be in accordance with the owner's and OSHA requirements.

B. Provide and install R-TankLD/, R-TankHD/, R-TankSD/, or R-TankU/D/ system (hereafter called R-Tank) and all related products including fill materials, geotextiles, geogrids, inlet and outlet pipe with connections per the manufacturer's installation guidelines provided in this section.

C. Provide and construct the cover of the R-Tank system including; stone backfill, structural fill cover, and pavement section as specified.

D. Protect R-Tank system from construction traffic after installation until completion of all construction activity in the installation area.

1.03 QUALITY CONTROL

A. All materials shall be manufactured in ISO certified facilities.

B. Installation Contractor shall demonstrate the following experience:

1. A minimum of three R-Tank or equivalent projects completed within 2 years; and,
2. A minimum of 25,000 cubic feet of storage volume completed within 2 years.
3. Contractor experience requirement may be waived if the manufacturer's representative provides on-site training and review during construction.

C. Installation Personnel: Performed only by skilled workers with satisfactory record of performance on bulk earthworks, pipe, chamber, or pond/landfill construction projects of comparable size and quality.

D. Contractor must have manufacturer's representative available for site review if requested by Owner.

1.04 SUBMITTALS

A. Submit proposed R-Tank layout drawings. Drawings shall include typical section details as well as the required base elevation of stone and tanks, minimum cover requirements and tank configuration.

B. Submit manufacturer's product data, including compressive strength and unit weight.

C. Submit manufacturer's installation instructions.

D. Submit R-Tank sample for review. Reviewed and accepted samples will be returned to the Contractor.

E. Submit material certificates for geotextile, geogrid, base course and backfill materials.

F. Submit required experience and personnel requirements as specified in Section 1.03.

G. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data that meets or exceeds criteria in Table 2.01 B.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect R-Tank and other materials from damage during delivery, and store UV sensitive materials under tarp to protect from sunlight when time from delivery to installation exceeds two weeks. Storage of materials should be on smooth surfaces, free from dirt, mud and debris.

B. Handling is to be performed with equipment appropriate to the materials and site conditions, and may include hand, handcart, forklifts, extension lifts, etc.

C. Cold weather:

1. Care must be taken when handling plastics when air temperature is 40 degrees or below as plastic becomes brittle.
2. Do not use frozen materials or materials mixed or coated with ice or frost.
3. Do not build on frozen ground or wet, saturated or muddy subgrade.

1.06 PREINSTALLATION CONFERENCE.

A. Prior to the start of the installation, a preinstallation conference shall occur with the representatives from the design team, the general contractor, the excavation contractor, the R-Tank installation contractor, and the manufacturer's representative.

1.07 PROJECT CONDITIONS

A. Coordinate installation for the R-Tank system with other on-site activities to eliminate all non-installation related construction traffic over the completed R-Tank system. No loads heavier than the design loads shall be allowed over the system, and in no case shall loads higher than a standard AASHTO HS20 (or HS25, depending on design criteria) load be allowed on the system at any time.

B. Protect adjacent work from damage during R-Tank system installation.

C. All pre-treatment systems to remove debris and heavy sediments must be in place and functional prior to operation of the R-Tank system. Additional pretreatment measures may be needed if unit is operational during construction due to increased sediment loads.

D. Contractor is responsible for any damage to the system during construction.

PART 2 - PRODUCTS

2.01 R-TANK UNITS

A. R-Tank - Injection molded plastic tank plates assembled to form a 95% void modular structure of predesigned height (custom for each project).

B. R-Tank units shall meet the following Physical & Chemical Characteristics:

PROPERTY	DESCRIPTION	R-Tank^{LD} VALUE	R-Tank^{HD} VALUE	R-Tank^{SD} VALUE	R-Tank^{UD} VALUE
Void Area	Volume available for water storage	95%	95%	95%	95%
Surface Void Area	Percentage of exterior available for infiltration	90%	90%	90%	90%
Vertical Compressive Strength	ASTM D 2412 / ASTM F 2418	30.0 psi	33.4 psi	42.9 psi	134.2 psi
Lateral Compressive Strength	ASTM D 2412 / ASTM F 2418	20.0 psi	22.4 psi	28.9 psi	N/A
HS-20 Minimum Cover	Cover required to support HS-20 loads	N/A	20"	18"	12" (STONE BACKFILL)
HS-25 Minimum Cover	Cover required to support HS-25 loads	N/A	24"	19"	15" (STONE BACKFILL)
Maximum Cover	Maximum allowable cover depth	3 feet	< 7 feet	< 10 feet	5 feet
Unit Weight	Weight of plastic per cubic foot of tank	3.29 lbs / cf	3.62 lbs/cf	3.96 lbs / cf	4.33 lbs / cf
Rib Thickness	Thickness of load-bearing members	0.18 inches	0.18 inches	0.18 inches	N/A
Service Temperature	Safe temperature range for use	-14 – 167° F	-14 – 167° F	-14 – 167° F	-14 – 167° F

C. Supplier: ACF West 15540 Woodinville-Redmond Rd., Woodinville, Washington 98072, (425) 415-6115, www.acfwest.com

2.02 GEOSYNTHETICS

A. Geotextile. A geotextile envelope is required to prevent backfill material from entering the R-Tank modules.

1. Standard Application: The standard geotextile shall be an 8 oz per square yard nonwoven geotextile (TenCate Mirafi 180N or equivalent).
2. Infiltration Applications: When water must infiltrate/exfiltrate through the geotextile as a function of the system design, a woven monofilament (TenCate Mirafi FW402 or equivalent) shall be used.

B. Geogrid. For installations subject to traffic loads and/or when required by project plans, install geogrid (Naue Secugrid 30/30 or equivalent) to reinforce backfill above the R-Tank system. Geogrid is not always required for R-TankUD/ installations, and is often not required for non-traffic load applications.

2.03 BACKFILL & COVER MATERIALS

A. Bedding Materials: Stone (angular and smaller than 1.5" in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System) shall be used below the R-Tank system (3" minimum). Material must be free from lumps, debris, and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation. For infiltration applications bedding material shall be free draining.

B. Side and Top Backfill: Material must be free from lumps, debris and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

1. Traffic Applications - Free draining material shall be used adjacent to (24" minimum) and above (for the first 12") the R-Tank system.

a. For HD, and SD modules, backfill materials shall be free draining stone (angular and smaller than 1.5" in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System).

b. For UD modules with less than 14" of top cover, backfill materials shall be free draining stone (angular and smaller than 1.5" in diameter). The use of soil backfill on the sides and top of the UD module is not permitted unless the modules are installed outside of traffic areas or with cover depths of 14" or more. Top backfill material (from top of module to bottom of pavement base or 12" maximum) must be consistent with side backfill.

2. Non-Traffic / Green Space Applications - For all R-Tank modules installed in green spaces and not subjected to vehicular loads, backfill materials may either follow the guidelines for Traffic Applications above, or the top backfill layer (12" minimum) may consist of AASHTO #57 stone blended with 30-40% (by volume) topsoil to aid in establishing vegetation.

C. Additional Cover Materials: Structural Fill shall consist of granular materials meeting the gradational requirements of SM, SP, SW, GM, GP or GW as classified by the Unified Soil Classification System. Structural fill shall have a maximum of 25 percent passing the No. 200 sieve, shall have a maximum clay content of 10 percent and a maximum Plasticity Index of 4. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

2.04 OTHER MATERIALS

A. Utility Marker: Install metallic tape at corners of R-Tank system to mark the area for future utility detection.

PART 3 - EXECUTION

3.01 ASSEMBLY OF R-TANK UNITS

A. Assembly of modules shall be performed in accordance with the R-Tank Installation Manual, Section 2.

3.02 LAYOUT AND EXCAVATION

A. Installer shall stake out, excavate, and prepare the subgrade area to the required plan grades and dimensions, ensuring that the excavation is at least 2 feet greater than R-Tank dimensions in each direction allowing for installation of geotextile filter fabric, R-Tank modules, and free draining backfill materials.

B. All excavations must be prepared with OSHA approved excavated sides and sufficient working space.

C. Protect partially completed installation against damage from other construction traffic by establishing a perimeter with high visibility construction tape, fencing, barricades, or other means until construction is complete.

D. Base of the excavation shall be uniform, level, and free of lumps or debris and soft or yielding subgrade areas. A minimum 2,000 pounds per square foot bearing capacity is required.

1. Standard Applications: Compact subgrade to a minimum of 95% of Standard Proctor (ASTM D698) density or as required by the Owner's engineer.
2. Infiltration Applications: Subgrade shall be prepared in accordance with the contract documents. Compaction of subgrade should not be performed in infiltration applications.

E. Unsuitable Soils or Conditions: All questions about the base of the excavation shall be directed to the owner's engineer, who will approve the subgrade conditions prior to placement of stone. The owner's engineer shall determine the required bearing capacity of the R-Tank subgrade; however in no case shall a bearing capacity of less than 2,000 pounds per square foot be provided.

1. If unsuitable soils are encountered at the subgrade, or if the subgrade is pumping or appears excessively soft, repair the area in accordance with contract documents and/or as directed by the owner's engineer.
2. If indications of the water table are observed during excavation, the engineer shall be contacted to provide recommendations.
3. Do not start installation of the R-Tank system until unsatisfactory subgrade conditions are corrected and the subgrade conditions are accepted by the owner's engineer.

3.03 PREPARATION OF BASE

A. Place a thin layer (3" unless otherwise specified) of bedding material (Section 2.03 A), over the subgrade to establish a level working platform for the R-Tank modules. Level to within ½" (+/- ¼") or as shown on the plans. Native subgrade soils or other materials may be used if determined to meet the requirements of 2.03 A and are accepted by the owner's engineer.

1. Standard Applications: Static roll or otherwise compact bedding materials until they are firm and unyielding.
2. Infiltration Applications: Bedding materials shall be prepared in accordance with the contract documents.

B. Outline the footprint of the R-Tank system on the excavation floor using spray paint or chalk line to ensure a 2' perimeter is available around the R-Tank system for proper installation and compaction of backfill.

3.04 INSTALLATION OF THE R-TANKS

A. Where a geotextile wrap is specified on the stone base, cut strips to length and install in excavation, removing wrinkles so material lays flat. Overlap geotextile a minimum 12" or as recommended by manufacturer. Use tape, special adhesives, sandbags or other ballast to secure overlaps. As geotextiles can be damaged by extreme heat, smoking is not permissible on/near the geotextile, and tools using a flame to tack the overlaps, such as propane torches, are prohibited.

B. Where an impervious liner (for containment) is specified, install the liner per manufacturer's recommendations and the contract documents. The R-Tank units shall be separated from impervious liner by a non-woven geotextile fabric installed accordance with Section 3.04A.

C. Install R-Tank modules by placing side by side, in accordance with the design drawings. No lateral connections are required. It is advisable to use a string line to form square corners and straight edges along the perimeter of the R-Tank system. The modules are to be oriented as per the design drawing with required depth as shown on plans.

1. For LD, HD, and SD installations, the large side plate of the tank should be placed on the perimeter of the system. This will typically require that the two ends of the tank area will have a row of tanks placed perpendicular to all other tanks. If this is not shown in the construction drawings, it is a simple field adjustment that will have minimal effect on the overall system footprint. Refer to R-Tank Installation Guide for more details
2. For UD installations, there is no perpendicular end row required.

D. Wrap the R-Tank top and sides in specified geotextile. Cut strips of geotextile so that it will cover the sides and top, encapsulating the entire system to prevent backfill entry into the system. Overlap geotextile 12" or as recommended by manufacturer. Take great care to avoid damage to geotextile (and, if specified, impervious liner) during placement.

E. Identify locations of inlet, outlet and any other penetrations of the geotextile (and optional liner). These connections should be installed flush (butted up to the R-Tank) and the geotextile fabric shall be cut to enable hydraulic continuity between the connections and the R-Tank units. These connections shall be secured using pipe boots with stainless steel pipe clamps. Support pipe in trenches during backfill operations to prevent pipe from settling and damaging the geotextile, impervious liner (if specified) or pipe. Connecting pipes at 90 degree angles facilitates construction, unless otherwise specified. Ensure end of pipe is installed snug against R-Tank system.

F. Install Inspection and Maintenance Ports in locations noted on plans. At a minimum one maintenance port shall be installed within 10' of each inlet & outlet connection, and with a maximum spacing of one maintenance port for every 2,500 square feet. Install all ports as noted in the R-Tank Installation Guide.

G. If required, install ventilation pipes and vents as specified on drawings to provide ventilation for proper hydraulic performance. The number of pipes and vents will depend on the size of the system. Vents are often installed using a 90 degree elbow with PVC pipe into a landscaped area with 'U" bend or venting bollard to inhibit the ingress of debris. A ground level concrete or steel cover can be used.

3.05 BACKFILLING OF THE R-TANK UNITS

A. Backfill and fill with recommended materials as follows:

1. Place freely draining backfill materials (Section 2.03 B) around the perimeter in lifts with a maximum thickness of 12". Each lift shall be placed around the entire perimeter such that each lift is no more than 24" higher than the side backfill along any other location on the perimeter of the R-Tank system. No fill shall be placed over top of tanks until the side backfill has been completed.
2. Each lift shall be compacted at the specified moisture content to a minimum of 95% of the Standard Proctor Density until no further densification is observed (for self-compacting stone materials). The side lifts must be compacted with walk behind compaction equipment. Even when "self-compacting" backfill materials are selected, a walk behind vibratory compactor must be used.
3. Take care to ensure that the compaction process does not allow the machinery to come into contact with the modules due to the potential for damage to the geotextile and R-Tank units.
4. No compaction equipment is permissible to operate directly on the R-Tank modules.
5. Top Backfill: Only low pressure track vehicles shall be operated over the R-Tank system during construction. Dump Trucks and Pans shall not be operated within the R-Tank system footprint at any time. Heavy equipment should unload in an area adjacent to the R-Tank system and the material should be moved over the system using tracked equipment with an operating weight of less than 10 tons.
   a. Typical Applications: Install a 12" (or as shown on plans) lift of freely draining material (Section 2.03 B) over the R-Tank Units, maintaining 12" between equipment tracks and R-Tank System. Lightly compacted using a walk-behind trench roller. Alternately, a roller (maximum gross vehicle weight of 6 tons) may be used. Roller must remain in static mode until a minimum of 24" of cover has been placed over the modules. Sheep foot rollers should not be used.
   b. Shallow Applications (< 18" total cover): Install top backfill in accordance with plans.
6. If required, install a geogrid as shown on plans. Geogrid shall extend a minimum of 3 feet beyond the limits of the excavation wall.
7. Following placement and compaction of the initial cover, subsequent lifts of structural fill (Section 2.03 C) shall be placed at the specified moisture content and compacted to a minimum of 95% of the Standard Proctor Density and shall cover the entire footprint of the R-Tank system. During placement of fill above the system, unless otherwise specified, a uniform elevation of fill shall be maintained to within 12" across the footprint of the R-Tank system. Do not exceed maximum cover depths listed in Table 2.01 B.
8. Place additional layers of geotextile and/or geogrid at elevations as specified in the design details. Each layer of geosynthetic reinforcement placed above the R-Tank system shall extend a minimum of 3 feet beyond the limits of the excavation wall.

B. Ensure that all unrelated construction traffic is kept away from the limits of excavation until the project is complete and final surface materials are in place. No non-installation related loading should be allowed over the R-Tank system until the final design section has been constructed (including pavement).

C. Place surfacing materials, such as groundcovers (no large trees), or paving materials over the structure with care to avoid displacement of cover fill and damage to surrounding areas.

D. Backfill depth over R-Tank system must be within the limitations shown in the table in Section 2.01 B. If the total backfill depth does not comply with this table, contact engineer or manufacturer's representative for assistance.

3.06 MAINTENANCE REQUIREMENTS

A. A routine maintenance effort is required to ensure proper performance of the R-Tank system. The Maintenance program should be focused on pretreatment systems. Ensuring these structures are clean and functioning properly will reduce the risk of contamination of the R-Tank system and stormwater released from the site. Pre-treatment systems shall be inspected yearly, or as directed by the regulatory agency and by the manufacturer (for proprietary systems). Maintain as needed using acceptable practices or following manufacturer's guidelines (for proprietary systems).

B. All inlet pipes and Inspection and/or Maintenance Ports in the R-Tank system will need to be inspected for accumulation of sediments at least quarterly through the first year of operation and at least yearly thereafter.

C. If sediment has accumulated to the level noted in the R-Tank Maintenance Guide or beyond a level acceptable to the Owner's engineer, the R-Tank system should be flushed.

D. All inspection and maintenance activities should be performed in accordance with the R-Tank Operation, Inspection & Maintenance Manual.

SD R-TANK

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

ACF WEST INC. GEOSYNTHETICS

Products | Service | Solutions

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK SPECIFICATION
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 1

DRAWN BY
EDQ

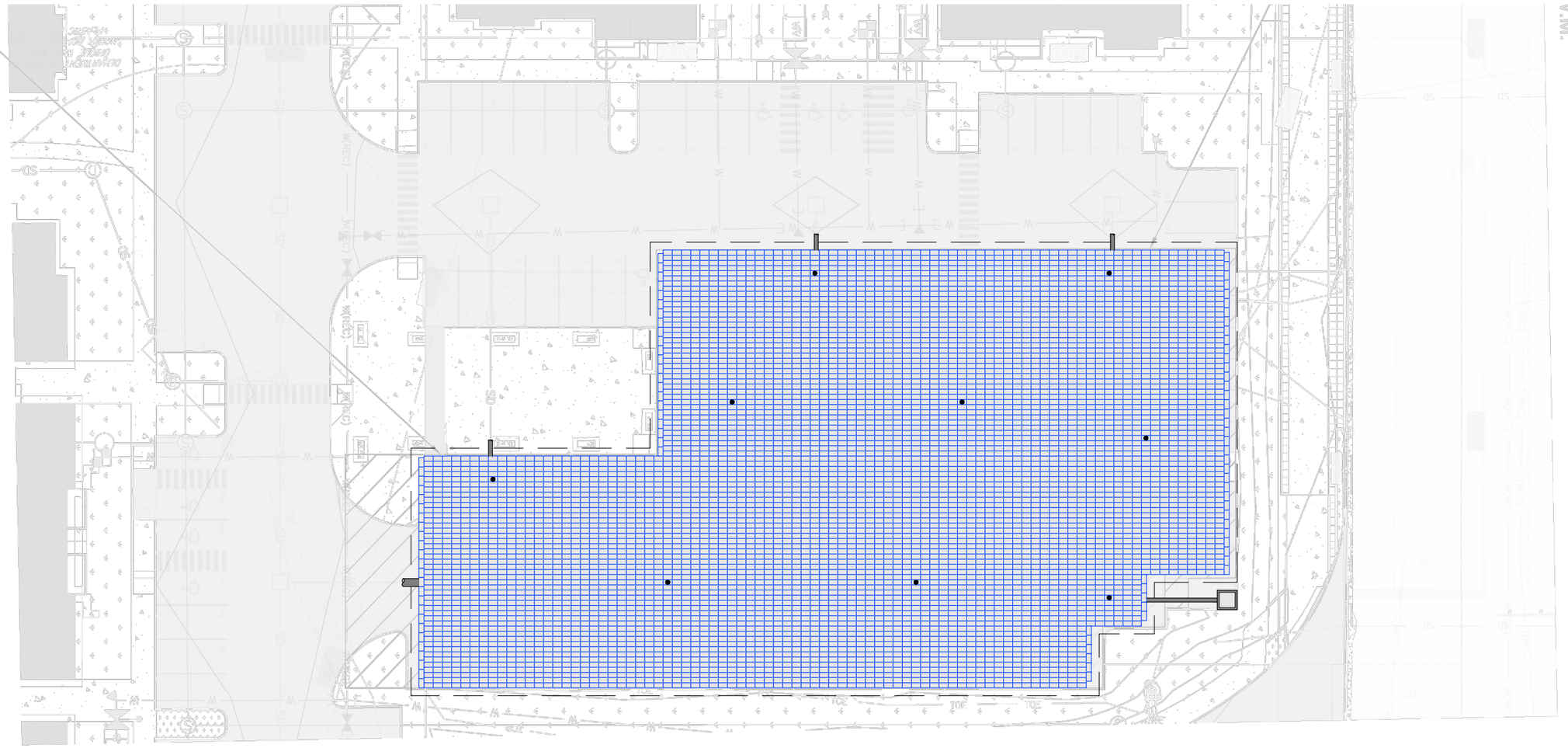
DATE
09/28/2023

ACF WEST PROJECT NUMBER
23-004WA

SHEET NO.
6 of 6

ACKNOWLEDGEMENT:
AN APPROVAL OF THE SUBMITTAL PLANS IS REQUIRED PRIOR TO MATERIAL ORDER. AS PART OF THE SUBMITTAL APPROVAL, THE ENGINEER OF RECORD HEREBY ACKNOWLEDGES THAT THE R-TANK SYSTEM IS NOT DESIGNED TO SUPPORT LOADS FROM BUILDINGS OR STRUCTURES. THEREFORE, THE ENGINEER OF RECORD HAS COORDINATED WITH THE PROPER DISCIPLINES TO ENSURE NO STRUCTURAL LOADS ARE IMPARTED UPON THE SYSTEM AND ANY INFILTRATION FROM THE SYSTEM HAS BEEN ACCOUNTED FOR IN THE FOUNDATION DESIGN.

NOTES:
- THE CONTRACTOR SHALL PARTICIPATE IN A PRECONSTRUCTION MEETING AND SIGN THE PRECONSTRUCTION CHECKLIST PRIOR TO MATERIAL INSTALLATION.
- DOCUMENTATION SHALL BE RECORDED BY THE CONTRACTOR OR ENGINEER OF RECORD SHOWING PROPER INSTALLATION OF THE SYSTEM AND ALL CONNECTIONS, IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS.
- IT IS HEREBY RECOMMENDED THAT THE R-TANK SYSTEM BE INSTALLED AFTER THE FOUNDATIONS HAVE BEEN INSTALLED TO ENSURE PROPER SEPARATION DISTANCES ARE MAINTAINED.



R-TANK^{SD} SYSTEM OVERLAY
SCALE: 1" = 30'

0 30' 60'
SCALE 1" = 30'

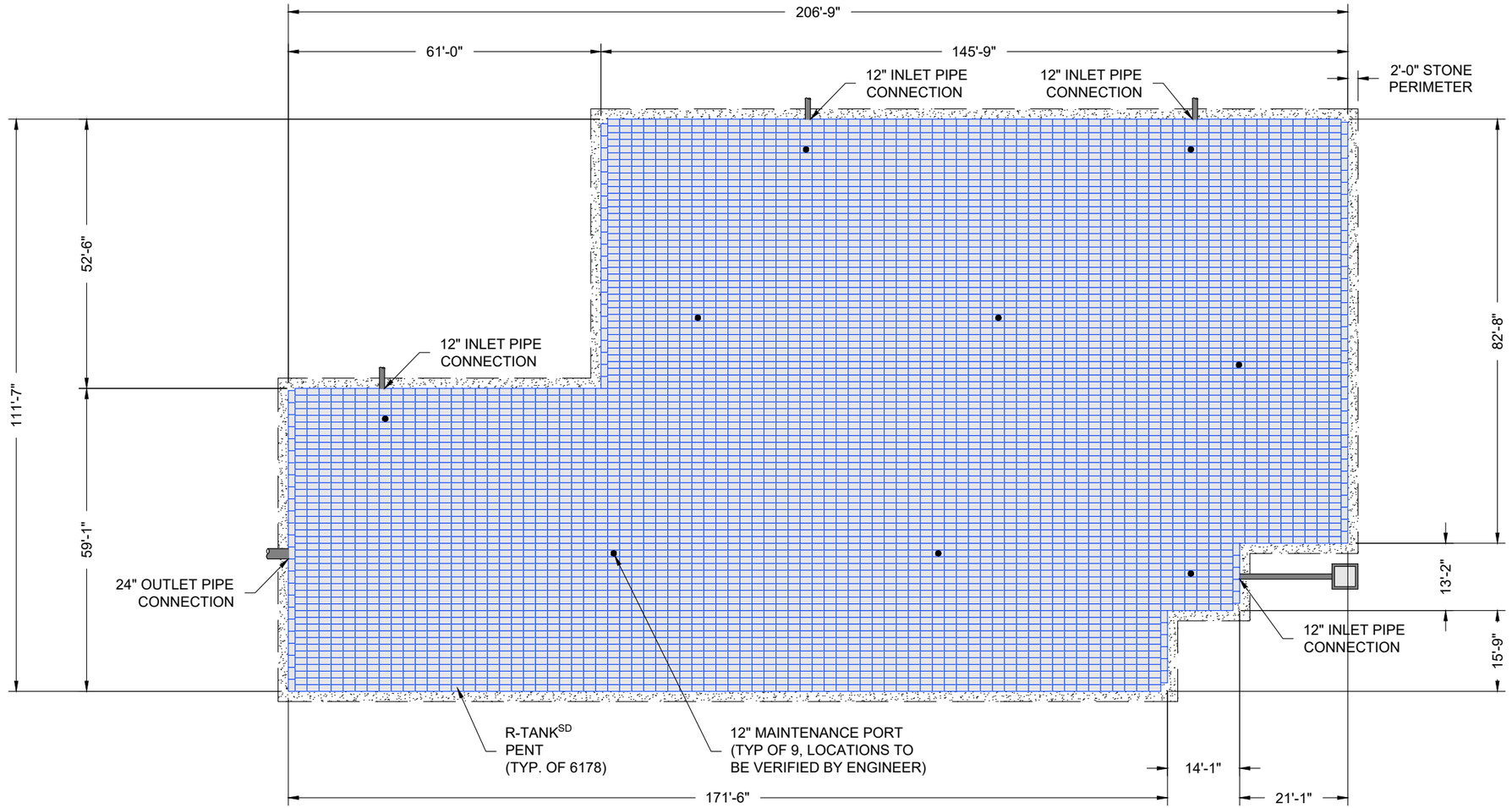
ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^{SD} SYSTEM OVERLAY
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 2

DRAWN BY
EDQ
DATE
09/28/2023
ACF WEST PROJECT NUMBER
23-004WA
SHEET NO.
1 of 6

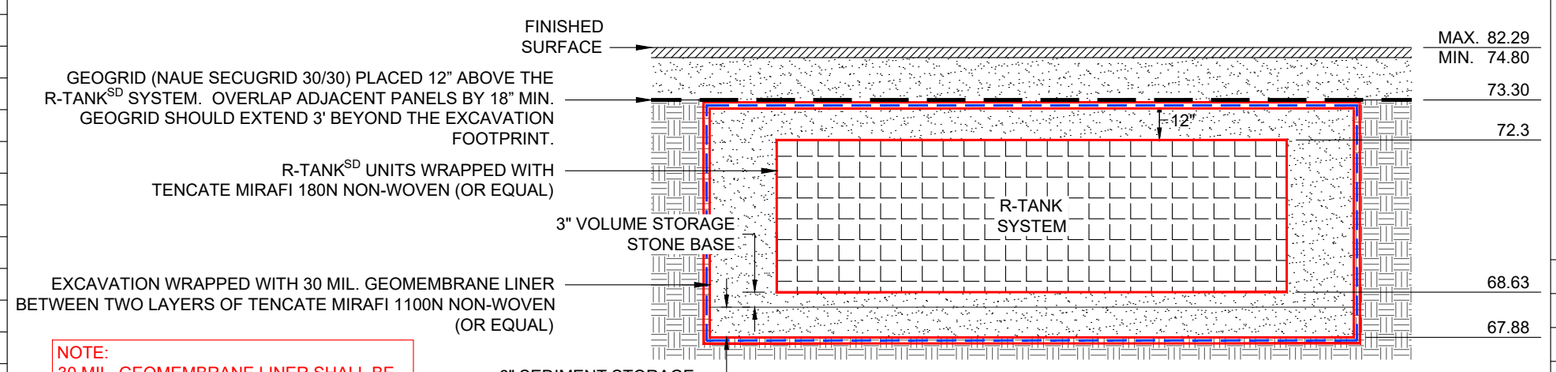
NOTE:
MINIMUM COVER FROM TOP OF TANK TO FINISH GRADE MUST BE AT LEAST 30" TO MEET A 45 KIP OUTRIGGER LOAD ON AN 18'X18" PAD.



NOTES:
1. DEAD STORAGE VOLUME FROM ELEVATION 67.88 TO 68.38 = 4,063 CF
2. LIVE STORAGE VOLUME FROM ELEVATION 68.38 TO 73.30 = 78,478 CF
3. ONLY 3" OF BASE STONE INCLUDED IN LIVE STORAGE VOLUME.

0 25' 50'
SCALE 1" = 25'

LAYOUT SCALE	1" = 25'
R-TANK^SD MODULE TYPE	PENT
TRAFFIC LOAD	45 KIP OUTRIGGER (18"X18")
# OF PENT R-TANKS	6,178
TOTAL SYSTEM STORAGE	78,478 CF
R-TANK STORAGE VOLUME	66,414 CF
STONE STORAGE VOLUME (40% VOID RATIO)	12,064 CF
TOP OF COVER STONE ELEV. (12")	73.30
NAUE SECUGRID 30/30 GEOGRID ELEV.	73.30
TOP OF R-TANK ELEV.	72.30
TANK INVERT	68.63
INVERT OF STONE BASE (9")	67.88
MIN. STONE PERIMETER WIDTH	2.0 FT
SEE SHEETS 3 - 6 FOR DETAILS AND ADDITIONAL INFORMATION	



NOTE:
30 MIL. GEOMEMBRANE LINER SHALL BE ULTRAVIOLET (UV) LIGHT RESISTANT.

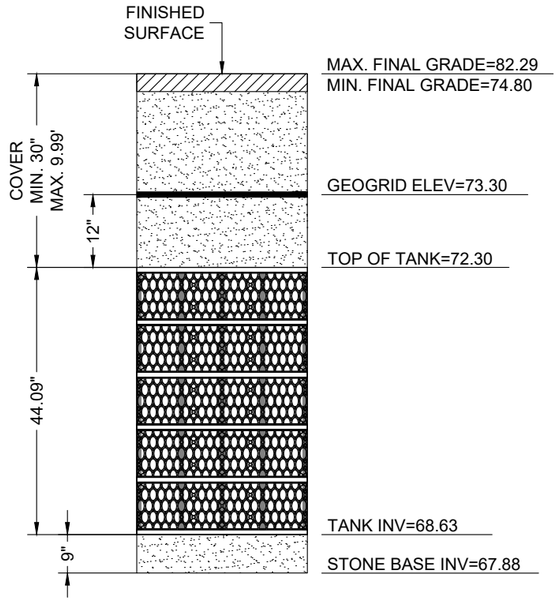
R-TANK^SD TANK WRAP & EXCAVATION ENVELOPE DETAIL

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

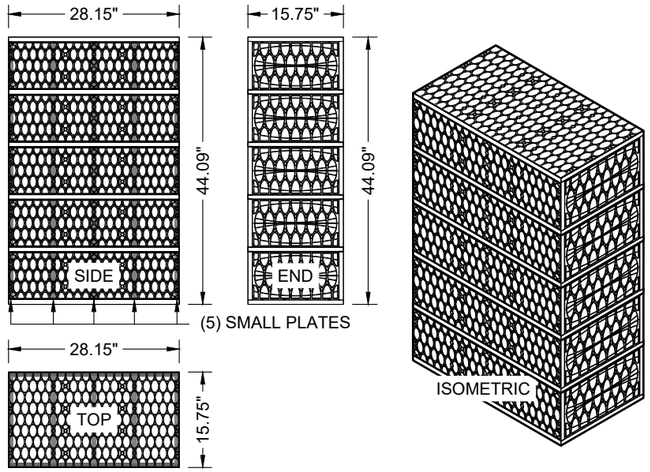
FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^SD SYSTEM LAYOUT
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 2

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA



PENT R-TANK^{SD} - ELEVATION



PENT R-TANK^{SD} - MODULE DETAIL

MODULE DATA

GEOMETRY:
LENGTH = 28.15 IN. (715 MM)
WIDTH = 15.75 IN. (400 MM)
HEIGHT = 44.09 IN. (1120 MM)
TANK VOLUME = 11.31 CF
STORAGE VOLUME = 10.75 CF
VOID INTERNAL VOLUME: 95%
VOID SURFACE AREA: 90%

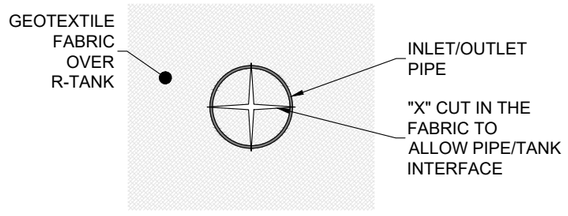
LOAD RATING:
42.9 PSI, (MODULE ONLY)
HS20/HS25 - SEE SPEC FOR COVER REQUIREMENTS
MATERIAL:
100% RECYCLED POLYPROPYLENE
SMALL PLATES REQUIRED:
5/SEGMENT, 25/MODULE

R-TANK^{SD} QUANTITIES	
R-TANK^{SD} MODULE TYPE	PENT
# OF PENT R-TANKS	6,178
TOTAL SYSTEM STORAGE	78,478 CF
R-TANK STORAGE VOLUME	66,414 CF
STONE STORAGE VOLUME (40% VOID RATIO)	12,064 CF
STONE BED FOOTPRINT	20,317 SF
STONE QUANTITY	1,493 CY
TENCATE MIRAFI 180N NON-WOVEN TANK WRAP	46,441 SF (5,160 SY)
30 MIL. GEOMEMBRANE LINER EXCAVATION WRAP	50,803 SF (5,645 SY)
TENCATE MIRAFI 1100N NON-WOVEN LINER PROTECTION	101,606 SF (11,290 SY)
NAUE SECUGRID 30/30 GEOGRID	25,657 SF (2,851 SY)
12" MAINTENANCE PORTS	9
12" PIPE BOOTS	4
24" PIPE BOOTS	1
TRASHGUARD PLUS UNITS (RECOMMENDED)	4
NOTE: STONE QUANTITY INCLUDES 12" OF COVER AND 9" OF BASE.	
NOTE: GEOTEXTILE / LINER QUANTITIES INCLUDE A 15% WASTE FACTOR.	

NOTE:
30 MIL. GEOMEMBRANE LINER SHALL BE ULTRAVIOLET (UV) LIGHT RESISTANT.

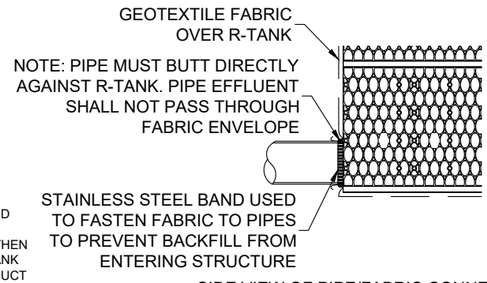
NOTES:
1. DEAD STORAGE VOLUME FROM ELEVATION 67.88 TO 68.38 = 4,063 CF
2. LIVE STORAGE VOLUME FROM ELEVATION 68.38 TO 73.30 = 78,478 CF
3. ONLY 3" OF BASE STONE INCLUDED IN LIVE STORAGE VOLUME.

CUT AN "X" IN THE FABRIC ENVELOPE THAT IS SLIGHTLY LARGER THAN THE PIPE. PULL THE FABRIC FLAPS AROUND THE PIPE, AND SEAL WITH A STAINLESS STEEL BAND.

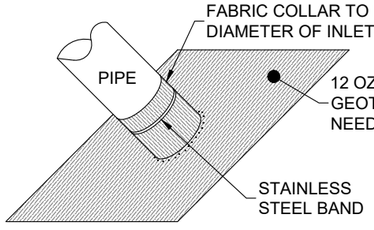


END VIEW OF PIPE/FABRIC CONNECTION

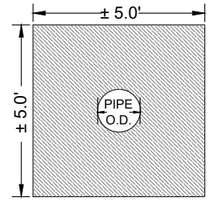
AFTER TANK WRAP IS SECURED TO PIPE, SLIDE BOOT AGAINST R-TANK AND SECURE WITH SECOND STAINLESS STEEL BAND, THEN ATTACH BOOT FLAP TO TANK ENVELOPE FABRIC WITH DUCT TAPE OR OTHER ADHESIVE.



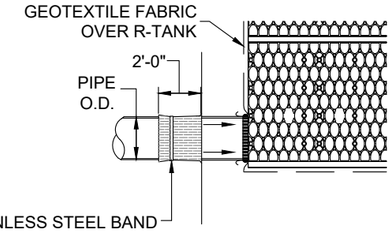
SIDE VIEW OF PIPE/FABRIC CONNECTION



GEOTEXTILE BOOT



FRONT VIEW OF GEOTEXTILE BOOT



SIDE VIEW OF GEOTEXTILE BOOT

R-TANK^{SD} TYPICAL TANK INLET/OUTLET W/ GEOTEXTILE PIPE BOOT DETAIL

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
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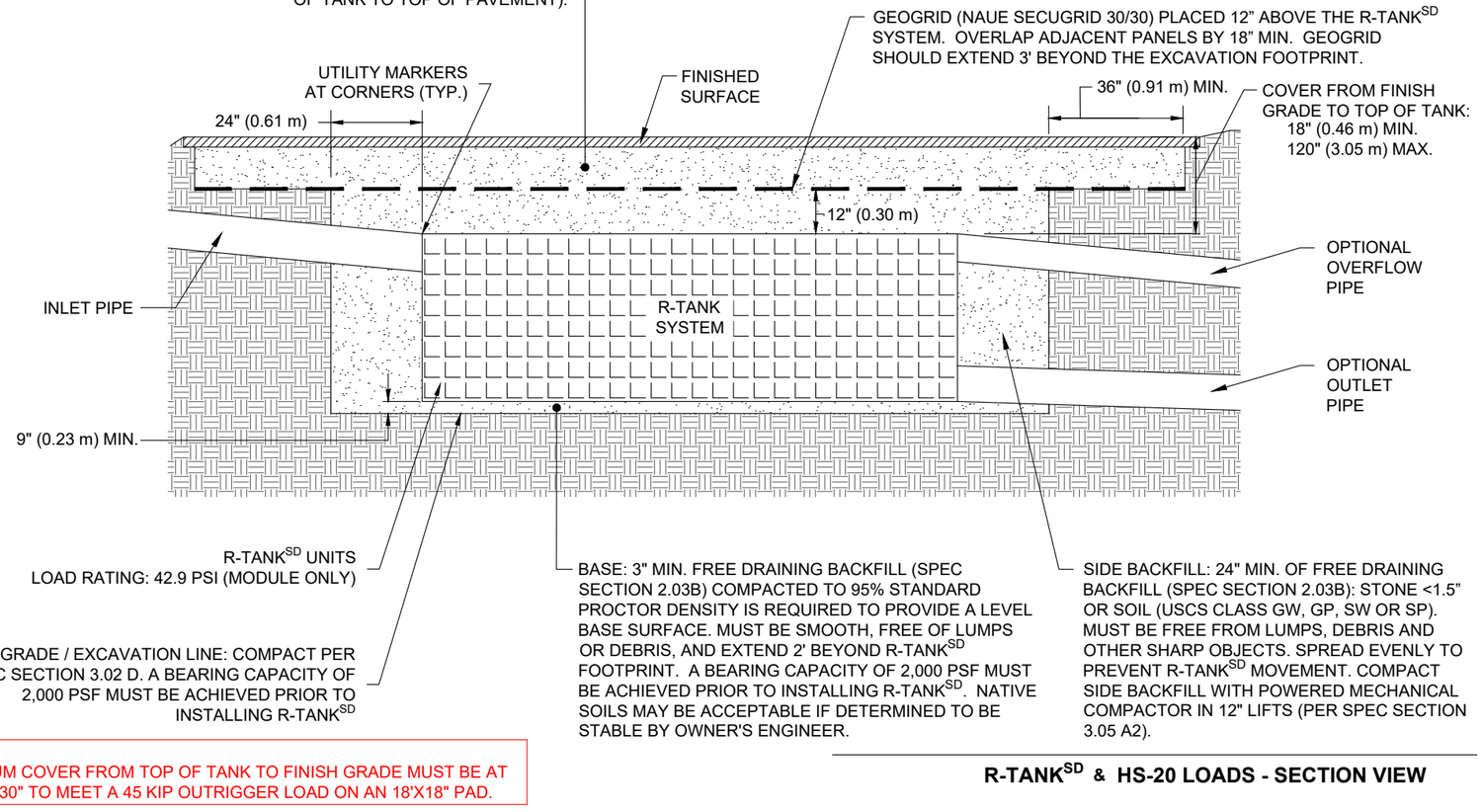
R-TANK^{SD} SYSTEM DETAILS
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 2

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA

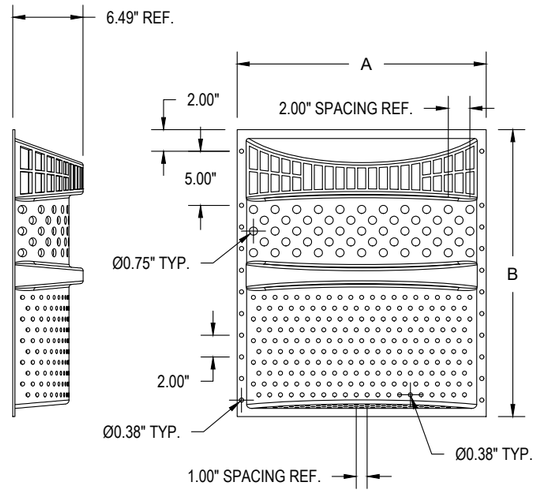
TOTAL COVER: 18" MINIMUM AND 120" MAXIMUM. FIRST 12" MUST BE FREE DRAINING BACKFILL (SPEC SECTION 2.03B): STONE <1.5" OR SOIL (USCS CLASS GW, GP, SW OR SP). ADDITIONAL FILL MAY BE STRUCTURAL FILL (SPEC SECTION 2.03C): STONE OR SOIL (USCS CLASS SM, SP, SW, GM, GP OR GW) WITH MAX CLAY CONTENT<10%, MAX 25% PASSING NO. 200 SIEVE, AND MAX PLASTICITY INDEX OF 4. A MIN. 12" COVER MUST BE MAINTAINED BETWEEN BACKFILL EQUIPMENT AND THE TOP OF THE R-TANK™ SYSTEM AT ALL TIMES. TOTAL HEIGHT OF TOP BACKFILL SHOULD NOT EXCEED 10'. CONTACT ACF WEST IF MORE THAN 10' OR LESS THAN 18" OF TOP BACKFILL IS REQUIRED (FROM TOP OF TANK TO TOP OF PAVEMENT).

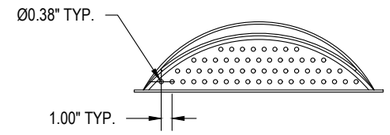
NOTES:
1. FOR COMPLETE MODULE DATA, SEE APPROPRIATE R-TANK^{SD} MODULE SHEET .
2. INSTALLATIONS PER THIS DETAIL MEET GUIDELINES OF HL-93 LOADING PER THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, CUSTOMARY U.S. UNITS, 7TH EDITION, 2014 WITH 2015 AND 2016 INTERIM REVISIONS.
3. PRE-TREATMENT STRUCTURES NOT SHOWN.
4. FOR INFILTRATION APPLICATIONS, GEOTEXTILE ENVELOPING R-TANK SHALL BE TENCATE MIRAFI FW-402 WOVEN (PER SPEC SECTION 2.02A) AND BASE SHALL BE 4" MIN. UNCOMPACTED FREE DRAINING BACKFILL (SPEC SECTION 2.03A) TO PROVIDE A LEVEL BASE. SURFACE MUST BE SMOOTH, FREE OF LUMPS OR DEBRIS, AND EXTEND 2' BEYOND R-TANK^{SD} FOOTPRINT.



NOTE:
MINIMUM COVER FROM TOP OF TANK TO FINISH GRADE MUST BE AT LEAST 30" TO MEET A 45 KIP OUTRIGGER LOAD ON AN 18'X18" PAD.

R-TANK^{SD} & HS-20 LOADS - SECTION VIEW





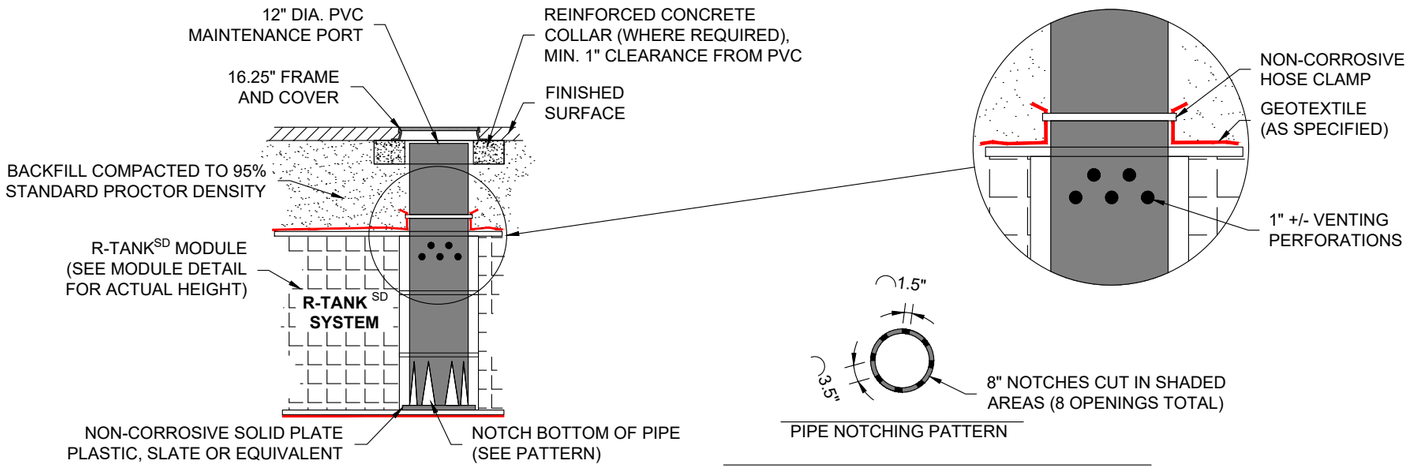
SIZE	A	B
23" x 24"	23"	26.51"
28" x 30"	28"	33.15"
34" x 36"	34"	38.69"

±0.25" TOLERANCE ON DIMENSIONS

NOTE:
TRASHGUARD PLUS UNITS ARE RECOMMENDED TO BE INSTALLED IN ALL CATCH BASINS DIRECTLY CONNECTED UPSTREAM OF THE R-TANK SYSTEM.

TRASHGUARD PLUS PRETREATMENT DETAIL

NOTES
1. THIS PORT IS USED TO PUMP WATER INTO THE SYSTEM AND RE-SUSPEND ACCUMULATED SEDIMENT SO THAT IT MAY BE PUMPED OUT.
2. MINIMUM REQUIRED MAINTENANCE INCLUDES A QUARTERLY INSPECTION DURING THE FIRST YEAR OF OPERATION AND A YEARLY INSPECTION THEREAFTER. FLUSH AS NEEDED.
3. R-TANK^{HD}, R-TANK^{SD}, R-TANK^{UD} AND R-TANK^{XD} MAY BE USED IN TRAFFIC APPLICATIONS.
4. SEE TRAFFIC LOADING DETAIL FOR MINIMUM & MAXIMUM COVER REQUIREMENTS.
5. IF MAINTENANCE PORT IS LOCATED IN A NON-TRAFFIC AREA, A PLASTIC CAP CAN BE USED IN LIEU OF A FRAME AND COVER WITH CONCRETE COLLAR.



R-TANK^{SD} TYPICAL MAINTENANCE PORT

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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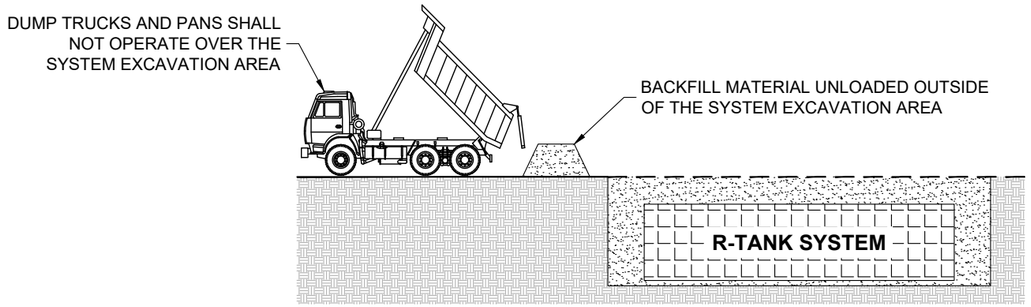
R-TANK^{SD} SYSTEM DETAILS
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 2

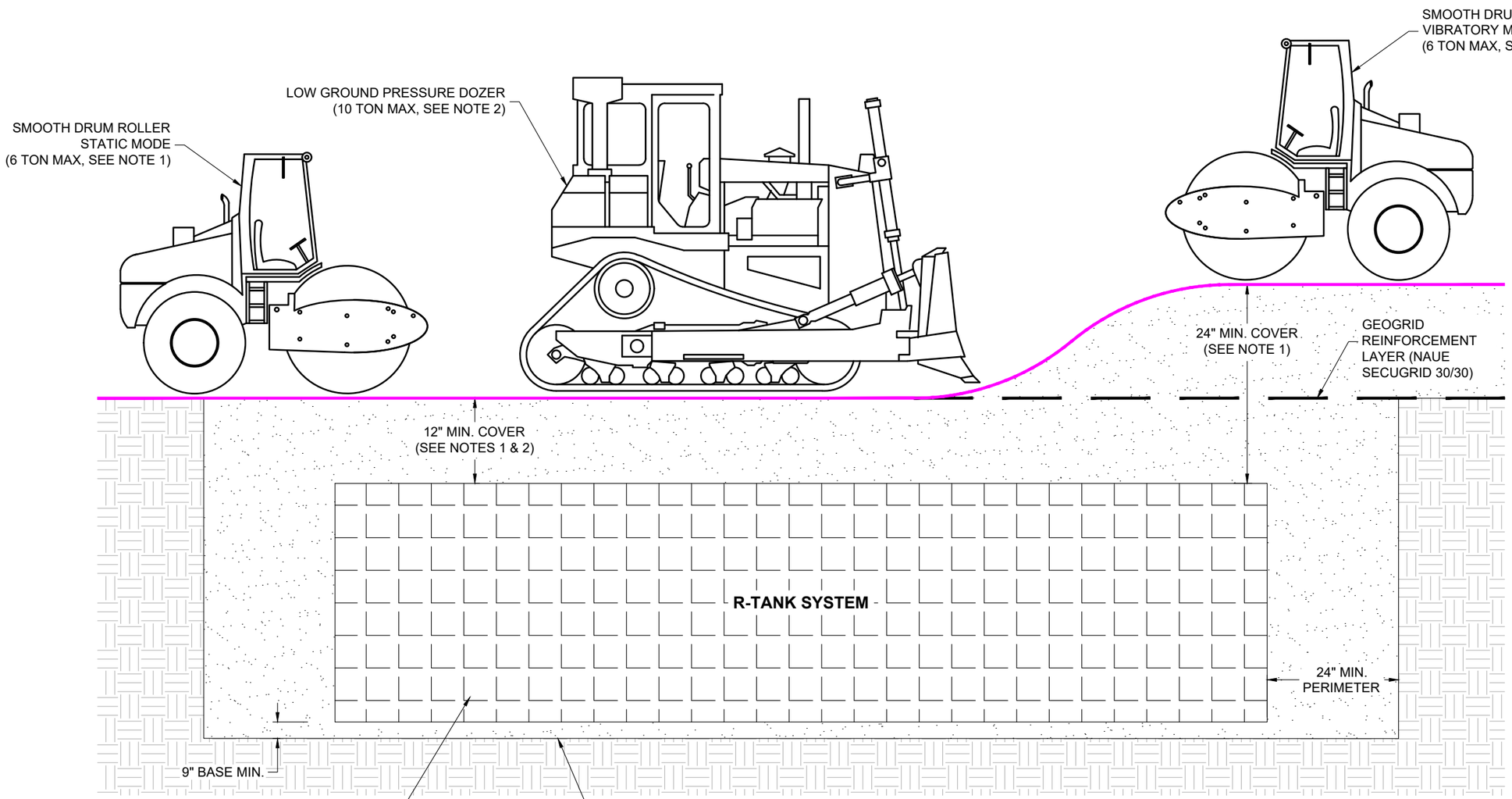
DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA
SHEET NO.: 4 of 6



DUMP TRUCK DETAIL (SEE NOTE 3)

NOTES:

1. FOLLOWING PLACEMENT OF SIDE BACKFILL, A UNIFORM 12" LIFT OF THE FREELY DRAINING MATERIAL (SPEC SECTION 2.03 B2) SHALL BE PLACED OVER THE R-TANK AND LIGHTLY COMPACTED USING A WALK-BEHIND TRENCH ROLLER. ALTERNATELY, A ROLLER (MAXIMUM GROSS VEHICLE WEIGHT OF 6 TONS) MAY BE USED. ROLLER MUST REMAIN IN STATIC MODE UNTIL A MINIMUM OF 24" OF COVER HAS BEEN PLACED OVER THE MODULES. SHEEP FOOT ROLLERS SHOULD NOT BE USED. **SPEC SECTION 3.05 A5**
2. ONLY LOW PRESSURE TIRE OR TRACK VEHICLES (LESS THAN 7 PSI AND OPERATING WEIGHT OF LESS THAN 20,000 LBS) SHALL BE OPERATED OVER THE R-TANK SYSTEM DURING CONSTRUCTION. **SPEC SECTION 3.05 A5**
3. DUMP TRUCKS AND PANS SHALL NOT BE OPERATED WITHIN THE R-TANK SYSTEM AT ANY TIME. WHERE NECESSARY, THE HEAVY EQUIPMENT SHOULD UNLOAD IN AN AREA ADJACENT TO THE R-TANK SYSTEM AND THE MATERIAL SHOULD BE MOVED OVER THE SYSTEM WITH TRACKED EQUIPMENT. **SPEC SECTION 3.05 A5**
4. ENSURE THAT ALL UNRELATED CONSTRUCTION TRAFFIC IS KEPT AWAY FROM THE LIMITS OF EXCAVATION UNTIL THE PROJECT IS COMPLETE AND FINAL SURFACE MATERIALS ARE IN PLACE. NO NON-INSTALLATION RELATED LOADING SHOULD BE ALLOWED OVER THE R-TANK SYSTEM UNTIL THE FINAL DESIGN SECTION HAS BEEN CONSTRUCTED (INCLUDING PAVEMENT). **SPEC SECTION 3.05 B**
5. SEE R-TANK INSTALLATION GUIDE OR CONTACT YOUR LOCAL ACF WEST REPRESENTATIVE FOR ADDITIONAL INFORMATION.



CONSTRUCTION EQUIPMENT COVER DETAIL - VEHICULAR TRAFFIC

R-TANK

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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R-TANK^SD CONSTRUCTION EQUIPMENT COVER DETAIL
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 2

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA
SHEET NO.: 5 of 6

R-TANK SPECIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, technical specification and general provisions of the Contract as modified herein apply to this section.

1.02 DESCRIPTION OF WORK INCLUDED

A. Provide excavation and base preparation per geotechnical engineer's recommendations and/or as shown on the design drawings, to provide adequate support for project design loads and safety from excavation sidewall collapse. Excavations shall be in accordance with the owner's and OSHA requirements.

B. Provide and install R-TankLD/, R-TankHD/, R-TankSD/, or R-TankU/D/ system (hereafter called R-Tank) and all related products including fill materials, geotextiles, geogrids, inlet and outlet pipe with connections per the manufacturer's installation guidelines provided in this section.

C. Provide and construct the cover of the R-Tank system including; stone backfill, structural fill cover, and pavement section as specified.

D. Protect R-Tank system from construction traffic after installation until completion of all construction activity in the installation area.

1.03 QUALITY CONTROL

A. All materials shall be manufactured in ISO certified facilities.

B. Installation Contractor shall demonstrate the following experience:

1. A minimum of three R-Tank or equivalent projects completed within 2 years; and,
2. A minimum of 25,000 cubic feet of storage volume completed within 2 years.
3. Contractor experience requirement may be waived if the manufacturer's representative provides on-site training and review during construction.

C. Installation Personnel: Performed only by skilled workers with satisfactory record of performance on bulk earthworks, pipe, chamber, or pond/landfill construction projects of comparable size and quality.

D. Contractor must have manufacturer's representative available for site review if requested by Owner.

1.04 SUBMITTALS

A. Submit proposed R-Tank layout drawings. Drawings shall include typical section details as well as the required base elevation of stone and tanks, minimum cover requirements and tank configuration.

B. Submit manufacturer's product data, including compressive strength and unit weight.

C. Submit manufacturer's installation instructions.

D. Submit R-Tank sample for review. Reviewed and accepted samples will be returned to the Contractor.

E. Submit material certificates for geotextile, geogrid, base course and backfill materials.

F. Submit required experience and personnel requirements as specified in Section 1.03.

G. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data that meets or exceeds criteria in Table 2.01 B.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect R-Tank and other materials from damage during delivery, and store UV sensitive materials under tarp to protect from sunlight when time from delivery to installation exceeds two weeks. Storage of materials should be on smooth surfaces, free from dirt, mud and debris.

B. Handling is to be performed with equipment appropriate to the materials and site conditions, and may include hand, handcart, forklifts, extension lifts, etc.

C. Cold weather:

1. Care must be taken when handling plastics when air temperature is 40 degrees or below as plastic becomes brittle.
2. Do not use frozen materials or materials mixed or coated with ice or frost.
3. Do not build on frozen ground or wet, saturated or muddy subgrade.

1.06 PREINSTALLATION CONFERENCE.

A. Prior to the start of the installation, a preinstallation conference shall occur with the representatives from the design team, the general contractor, the excavation contractor, the R-Tank installation contractor, and the manufacturer's representative.

1.07 PROJECT CONDITIONS

A. Coordinate installation for the R-Tank system with other on-site activities to eliminate all non-installation related construction traffic over the completed R-Tank system. No loads heavier than the design loads shall be allowed over the system, and in no case shall loads higher than a standard AASHTO HS20 (or HS25, depending on design criteria) load be allowed on the system at any time.

B. Protect adjacent work from damage during R-Tank system installation.

C. All pre-treatment systems to remove debris and heavy sediments must be in place and functional prior to operation of the R-Tank system. Additional pretreatment measures may be needed if unit is operational during construction due to increased sediment loads.

D. Contractor is responsible for any damage to the system during construction.

PART 2 - PRODUCTS

2.01 R-TANK UNITS

A. R-Tank - Injection molded plastic tank plates assembled to form a 95% void modular structure of predesigned height (custom for each project).

B. R-Tank units shall meet the following Physical & Chemical Characteristics:

PROPERTY	DESCRIPTION	R-Tank^{LD} VALUE	R-Tank^{HD} VALUE	R-Tank^{SD} VALUE	R-Tank^{UD} VALUE
Void Area	Volume available for water storage	95%	95%	95%	95%
Surface Void Area	Percentage of exterior available for infiltration	90%	90%	90%	90%
Vertical Compressive Strength	ASTM D 2412 / ASTM F 2418	30.0 psi	33.4 psi	42.9 psi	134.2 psi
Lateral Compressive Strength	ASTM D 2412 / ASTM F 2418	20.0 psi	22.4 psi	28.9 psi	N/A
HS-20 Minimum Cover	Cover required to support HS-20 loads	N/A	20"	18"	12" (STONE BACKFILL)
HS-25 Minimum Cover	Cover required to support HS-25 loads	N/A	24"	19"	15" (STONE BACKFILL)
Maximum Cover	Maximum allowable cover depth	3 feet	< 7 feet	< 10 feet	5 feet
Unit Weight	Weight of plastic per cubic foot of tank	3.29 lbs / cf	3.62 lbs/cf	3.96 lbs / cf	4.33 lbs / cf
Rib Thickness	Thickness of load-bearing members	0.18 inches	0.18 inches	0.18 inches	N/A
Service Temperature	Safe temperature range for use	-14 – 167° F	-14 – 167° F	-14 – 167° F	-14 – 167° F

C. Supplier: ACF West 15540 Woodinville-Redmond Rd., Woodinville, Washington 98072, (425) 415-6115, www.acfwest.com

2.02 GEOSYNTHETICS

A. Geotextile. A geotextile envelope is required to prevent backfill material from entering the R-Tank modules.

1. Standard Application: The standard geotextile shall be an 8 oz per square yard nonwoven geotextile (TenCate Mirafi 180N or equivalent).
2. Infiltration Applications: When water must infiltrate/exfiltrate through the geotextile as a function of the system design, a woven monofilament (TenCate Mirafi FW402 or equivalent) shall be used.

B. Geogrid. For installations subject to traffic loads and/or when required by project plans, install geogrid (Naue Secugrid 30/30 or equivalent) to reinforce backfill above the R-Tank system. Geogrid is not always required for R-TankUD/ installations, and is often not required for non-traffic load applications.

2.03 BACKFILL & COVER MATERIALS

A. Bedding Materials: Stone (angular and smaller than 1.5" in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System) shall be used below the R-Tank system (3" minimum). Material must be free from lumps, debris, and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation. For infiltration applications bedding material shall be free draining.

B. Side and Top Backfill: Material must be free from lumps, debris and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

1. Traffic Applications - Free draining material shall be used adjacent to (24" minimum) and above (for the first 12") the R-Tank system.

a. For HD, and SD modules, backfill materials shall be free draining stone (angular and smaller than 1.5" in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System).

b. For UD modules with less than 14" of top cover, backfill materials shall be free draining stone (angular and smaller than 1.5" in diameter). The use of soil backfill on the sides and top of the UD module is not permitted unless the modules are installed outside of traffic areas or with cover depths of 14" or more. Top backfill material (from top of module to bottom of pavement base or 12" maximum) must be consistent with side backfill.

2. Non-Traffic / Green Space Applications - For all R-Tank modules installed in green spaces and not subjected to vehicular loads, backfill materials may either follow the guidelines for Traffic Applications above, or the top backfill layer (12" minimum) may consist of AASHTO #57 stone blended with 30-40% (by volume) topsoil to aid in establishing vegetation.

C. Additional Cover Materials: Structural Fill shall consist of granular materials meeting the gradational requirements of SM, SP, SW, GM, GP or GW as classified by the Unified Soil Classification System. Structural fill shall have a maximum of 25 percent passing the No. 200 sieve, shall have a maximum clay content of 10 percent and a maximum Plasticity Index of 4. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

2.04 OTHER MATERIALS

A. Utility Marker: Install metallic tape at corners of R-Tank system to mark the area for future utility detection.

PART 3 - EXECUTION

3.01 ASSEMBLY OF R-TANK UNITS

A. Assembly of modules shall be performed in accordance with the R-Tank Installation Manual, Section 2.

3.02 LAYOUT AND EXCAVATION

A. Installer shall stake out, excavate, and prepare the subgrade area to the required plan grades and dimensions, ensuring that the excavation is at least 2 feet greater than R-Tank dimensions in each direction allowing for installation of geotextile filter fabric, R-Tank modules, and free draining backfill materials.

B. All excavations must be prepared with OSHA approved excavated sides and sufficient working space.

C. Protect partially completed installation against damage from other construction traffic by establishing a perimeter with high visibility construction tape, fencing, barricades, or other means until construction is complete.

D. Base of the excavation shall be uniform, level, and free of lumps or debris and soft or yielding subgrade areas. A minimum 2,000 pounds per square foot bearing capacity is required.

1. Standard Applications: Compact subgrade to a minimum of 95% of Standard Proctor (ASTM D698) density or as required by the Owner's engineer.
2. Infiltration Applications: Subgrade shall be prepared in accordance with the contract documents. Compaction of subgrade should not be performed in infiltration applications.

E. Unsuitable Soils or Conditions: All questions about the base of the excavation shall be directed to the owner's engineer, who will approve the subgrade conditions prior to placement of stone. The owner's engineer shall determine the required bearing capacity of the R-Tank subgrade; however in no case shall a bearing capacity of less than 2,000 pounds per square foot be provided.

1. If unsuitable soils are encountered at the subgrade, or if the subgrade is pumping or appears excessively soft, repair the area in accordance with contract documents and/or as directed by the owner's engineer.
2. If indications of the water table are observed during excavation, the engineer shall be contacted to provide recommendations.
3. Do not start installation of the R-Tank system until unsatisfactory subgrade conditions are corrected and the subgrade conditions are accepted by the owner's engineer.

3.03 PREPARATION OF BASE

A. Place a thin layer (3" unless otherwise specified) of bedding material (Section 2.03 A), over the subgrade to establish a level working platform for the R-Tank modules. Level to within ½" (+/- ¼") or as shown on the plans. Native subgrade soils or other materials may be used if determined to meet the requirements of 2.03 A and are accepted by the owner's engineer.

1. Standard Applications: Static roll or otherwise compact bedding materials until they are firm and unyielding.
2. Infiltration Applications: Bedding materials shall be prepared in accordance with the contract documents.

B. Outline the footprint of the R-Tank system on the excavation floor using spray paint or chalk line to ensure a 2' perimeter is available around the R-Tank system for proper installation and compaction of backfill.

3.04 INSTALLATION OF THE R-TANKS

A. Where a geotextile wrap is specified on the stone base, cut strips to length and install in excavation, removing wrinkles so material lays flat. Overlap geotextile a minimum 12" or as recommended by manufacturer. Use tape, special adhesives, sandbags or other ballast to secure overlaps. As geotextiles can be damaged by extreme heat, smoking is not permissible on/near the geotextile, and tools using a flame to tack the overlaps, such as propane torches, are prohibited.

B. Where an impervious liner (for containment) is specified, install the liner per manufacturer's recommendations and the contract documents. The R-Tank units shall be separated from impervious liner by a non-woven geotextile fabric installed accordance with Section 3.04A.

C. Install R-Tank modules by placing side by side, in accordance with the design drawings. No lateral connections are required. It is advisable to use a string line to form square corners and straight edges along the perimeter of the R-Tank system. The modules are to be oriented as per the design drawing with required depth as shown on plans.

1. For LD, HD, and SD installations, the large side plate of the tank should be placed on the perimeter of the system. This will typically require that the two ends of the tank area will have a row of tanks placed perpendicular to all other tanks. If this is not shown in the construction drawings, it is a simple field adjustment that will have minimal effect on the overall system footprint. Refer to R-Tank Installation Guide for more details
2. For UD installations, there is no perpendicular end row required.

D. Wrap the R-Tank top and sides in specified geotextile. Cut strips of geotextile so that it will cover the sides and top, encapsulating the entire system to prevent backfill entry into the system. Overlap geotextile 12" or as recommended by manufacturer. Take great care to avoid damage to geotextile (and, if specified, impervious liner) during placement.

E. Identify locations of inlet, outlet and any other penetrations of the geotextile (and optional liner). These connections should be installed flush (butted up to the R-Tank) and the geotextile fabric shall be cut to enable hydraulic continuity between the connections and the R-Tank units. These connections shall be secured using pipe boots with stainless steel pipe clamps. Support pipe in trenches during backfill operations to prevent pipe from settling and damaging the geotextile, impervious liner (if specified) or pipe. Connecting pipes at 90 degree angles facilitates construction, unless otherwise specified. Ensure end of pipe is installed snug against R-Tank system.

F. Install Inspection and Maintenance Ports in locations noted on plans. At a minimum one maintenance port shall be installed within 10' of each inlet & outlet connection, and with a maximum spacing of one maintenance port for every 2,500 square feet. Install all ports as noted in the R-Tank Installation Guide.

G. If required, install ventilation pipes and vents as specified on drawings to provide ventilation for proper hydraulic performance. The number of pipes and vents will depend on the size of the system. Vents are often installed using a 90 degree elbow with PVC pipe into a landscaped area with 'U" bend or venting bollard to inhibit the ingress of debris. A ground level concrete or steel cover can be used.

3.05 BACKFILLING OF THE R-TANK UNITS

A. Backfill and fill with recommended materials as follows:

1. Place freely draining backfill materials (Section 2.03 B) around the perimeter in lifts with a maximum thickness of 12". Each lift shall be placed around the entire perimeter such that each lift is no more than 24" higher than the side backfill along any other location on the perimeter of the R-Tank system. No fill shall be placed over top of tanks until the side backfill has been completed.
2. Each lift shall be compacted at the specified moisture content to a minimum of 95% of the Standard Proctor Density until no further densification is observed (for self-compacting stone materials). The side lifts must be compacted with walk behind compaction equipment. Even when "self-compacting" backfill materials are selected, a walk behind vibratory compactor must be used.
3. Take care to ensure that the compaction process does not allow the machinery to come into contact with the modules due to the potential for damage to the geotextile and R-Tank units.
4. No compaction equipment is permissible to operate directly on the R-Tank modules.
5. Top Backfill: Only low pressure track vehicles shall be operated over the R-Tank system during construction. Dump Trucks and Pans shall not be operated within the R-Tank system footprint at any time. Heavy equipment should unload in an area adjacent to the R-Tank system and the material should be moved over the system using tracked equipment with an operating weight of less than 10 tons.
   a. Typical Applications: Install a 12" (or as shown on plans) lift of freely draining material (Section 2.03 B) over the R-Tank Units, maintaining 12" between equipment tracks and R-Tank System. Lightly compacted using a walk-behind trench roller. Alternately, a roller (maximum gross vehicle weight of 6 tons) may be used. Roller must remain in static mode until a minimum of 24" of cover has been placed over the modules. Sheep foot rollers should not be used.
   b. Shallow Applications (< 18" total cover): Install top backfill in accordance with plans.
6. If required, install a geogrid as shown on plans. Geogrid shall extend a minimum of 3 feet beyond the limits of the excavation wall.
7. Following placement and compaction of the initial cover, subsequent lifts of structural fill (Section 2.03 C) shall be placed at the specified moisture content and compacted to a minimum of 95% of the Standard Proctor Density and shall cover the entire footprint of the R-Tank system. During placement of fill above the system, unless otherwise specified, a uniform elevation of fill shall be maintained to within 12" across the footprint of the R-Tank system. Do not exceed maximum cover depths listed in Table 2.01 B.
8. Place additional layers of geotextile and/or geogrid at elevations as specified in the design details. Each layer of geosynthetic reinforcement placed above the R-Tank system shall extend a minimum of 3 feet beyond the limits of the excavation wall.

B. Ensure that all unrelated construction traffic is kept away from the limits of excavation until the project is complete and final surface materials are in place. No non-installation related loading should be allowed over the R-Tank system until the final design section has been constructed (including pavement).

C. Place surfacing materials, such as groundcovers (no large trees), or paving materials over the structure with care to avoid displacement of cover fill and damage to surrounding areas.

D. Backfill depth over R-Tank system must be within the limitations shown in the table in Section 2.01 B. If the total backfill depth does not comply with this table, contact engineer or manufacturer's representative for assistance.

3.06 MAINTENANCE REQUIREMENTS

A. A routine maintenance effort is required to ensure proper performance of the R-Tank system. The Maintenance program should be focused on pretreatment systems. Ensuring these structures are clean and functioning properly will reduce the risk of contamination of the R-Tank system and stormwater released from the site. Pre-treatment systems shall be inspected yearly, or as directed by the regulatory agency and by the manufacturer (for proprietary systems). Maintain as needed using acceptable practices or following manufacturer's guidelines (for proprietary systems).

B. All inlet pipes and Inspection and/or Maintenance Ports in the R-Tank system will need to be inspected for accumulation of sediments at least quarterly through the first year of operation and at least yearly thereafter.

C. If sediment has accumulated to the level noted in the R-Tank Maintenance Guide or beyond a level acceptable to the Owner's engineer, the R-Tank system should be flushed.

D. All inspection and maintenance activities should be performed in accordance with the R-Tank Operation, Inspection & Maintenance Manual.

SD R-TANK

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R-TANK SPECIFICATION
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 2

DRAWN BY
EDQ

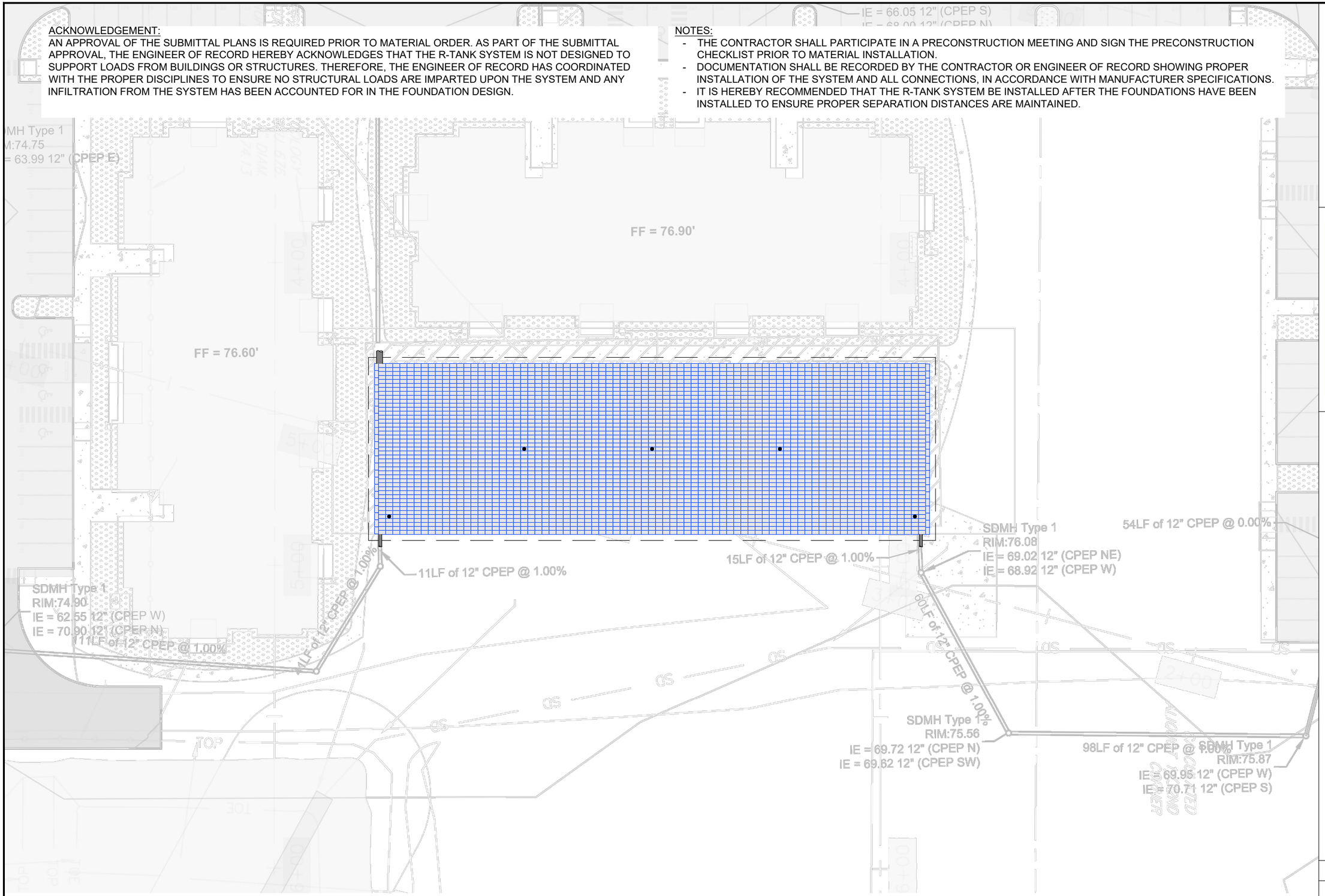
DATE
09/28/2023

ACF WEST PROJECT NUMBER
23-004WA

SHEET NO.
6 of 6

ACKNOWLEDGEMENT:
AN APPROVAL OF THE SUBMITTAL PLANS IS REQUIRED PRIOR TO MATERIAL ORDER. AS PART OF THE SUBMITTAL APPROVAL, THE ENGINEER OF RECORD HEREBY ACKNOWLEDGES THAT THE R-TANK SYSTEM IS NOT DESIGNED TO SUPPORT LOADS FROM BUILDINGS OR STRUCTURES. THEREFORE, THE ENGINEER OF RECORD HAS COORDINATED WITH THE PROPER DISCIPLINES TO ENSURE NO STRUCTURAL LOADS ARE IMPARTED UPON THE SYSTEM AND ANY INFILTRATION FROM THE SYSTEM HAS BEEN ACCOUNTED FOR IN THE FOUNDATION DESIGN.

NOTES:
- THE CONTRACTOR SHALL PARTICIPATE IN A PRECONSTRUCTION MEETING AND SIGN THE PRECONSTRUCTION CHECKLIST PRIOR TO MATERIAL INSTALLATION.
- DOCUMENTATION SHALL BE RECORDED BY THE CONTRACTOR OR ENGINEER OF RECORD SHOWING PROPER INSTALLATION OF THE SYSTEM AND ALL CONNECTIONS, IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS.
- IT IS HEREBY RECOMMENDED THAT THE R-TANK SYSTEM BE INSTALLED AFTER THE FOUNDATIONS HAVE BEEN INSTALLED TO ENSURE PROPER SEPARATION DISTANCES ARE MAINTAINED.



R-TANK^{HD} SYSTEM OVERLAY
SCALE: 1" = 30'

0 30' 60'
SCALE 1" = 30'

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
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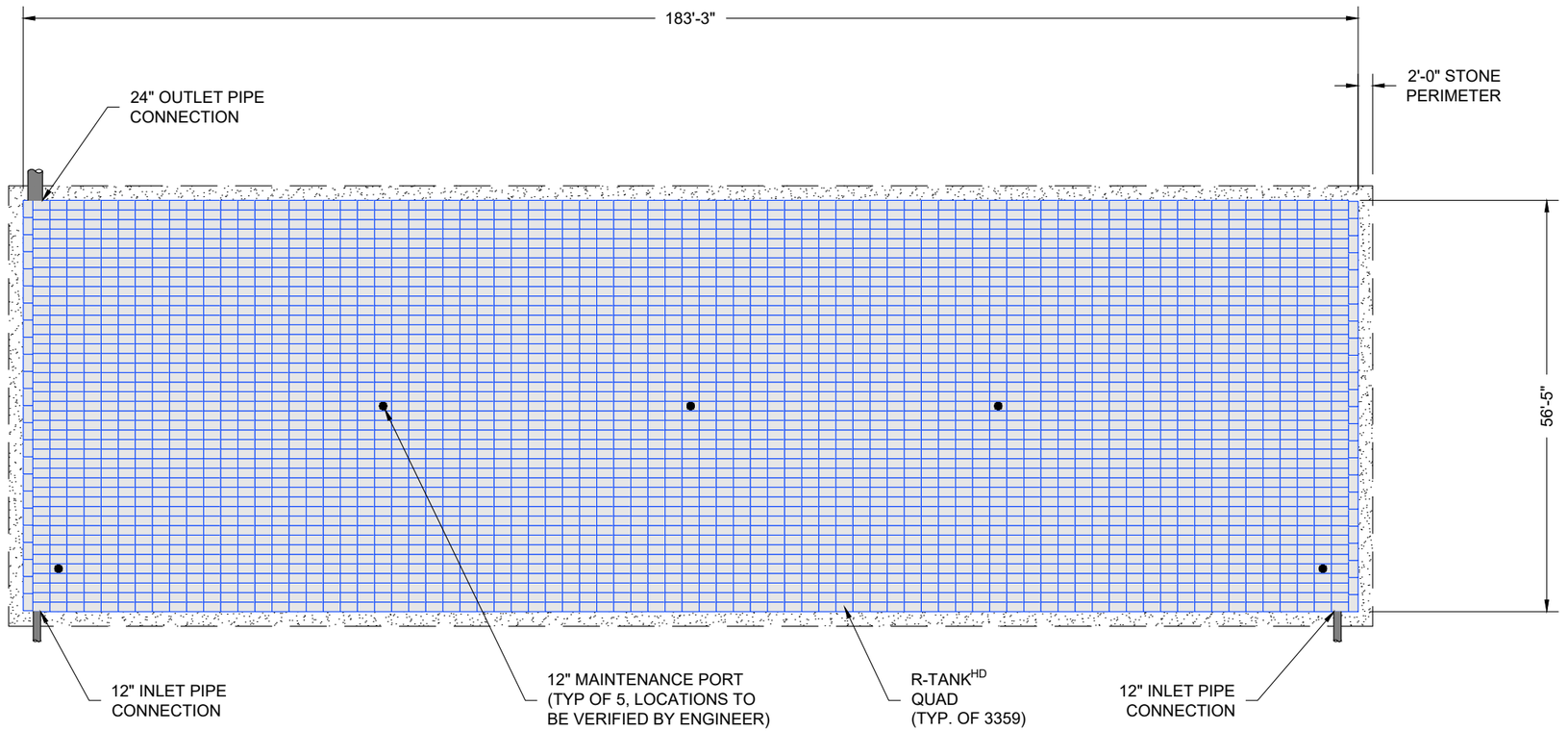
R-TANK^{HD} SYSTEM OVERLAY
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 3

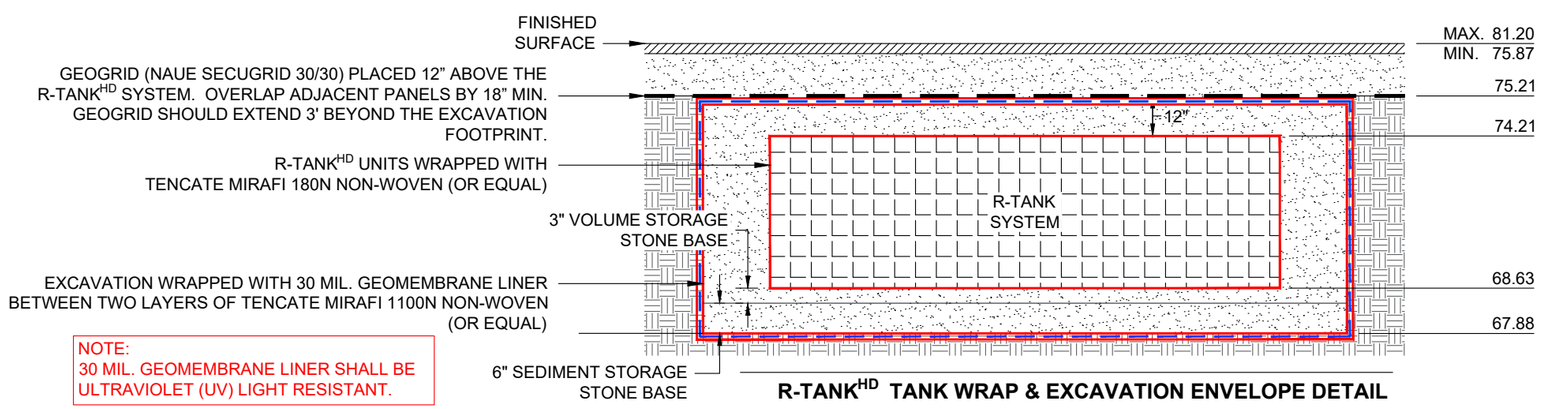
DRAWN BY
EDQ
DATE
09/28/2023
ACF WEST PROJECT NUMBER
23-004WA
SHEET NO.
1 of 6



NOTES:
1. DEAD STORAGE VOLUME FROM ELEVATION 67.88 TO 68.38 = 2,263 CF
2. LIVE STORAGE VOLUME FROM ELEVATION 68.38 TO 75.21 = 62,623 CF
3. ONLY 3" OF BASE STONE INCLUDED IN LIVE STORAGE VOLUME.

0 20' 40'
SCALE 1" = 20'

LAYOUT SCALE	1" = 20'
R-TANK^{HD} MODULE TYPE	QUAD
TRAFFIC LOAD	HS-20
# OF QUAD R-TANKS	3,359
TOTAL SYSTEM STORAGE	62,623 CF
R-TANK STORAGE VOLUME	54,785 CF
STONE STORAGE VOLUME (40% VOID RATIO)	7,838 CF
NAUE SECUGRID 30/30 GEOGRID ELEV.	75.21
TOP OF COVER STONE ELEV. (12")	75.21
TOP OF R-TANK ELEV.	74.21
TANK INVERT	68.63
INVERT OF STONE BASE (9")	67.88
MIN. STONE PERIMETER WIDTH	2.0 FT
SEE SHEETS 3 - 6 FOR DETAILS AND ADDITIONAL INFORMATION	



NOTE:
30 MIL. GEOMEMBRANE LINER SHALL BE ULTRAVIOLET (UV) LIGHT RESISTANT.

R-TANK^{HD} TANK WRAP & EXCAVATION ENVELOPE DETAIL

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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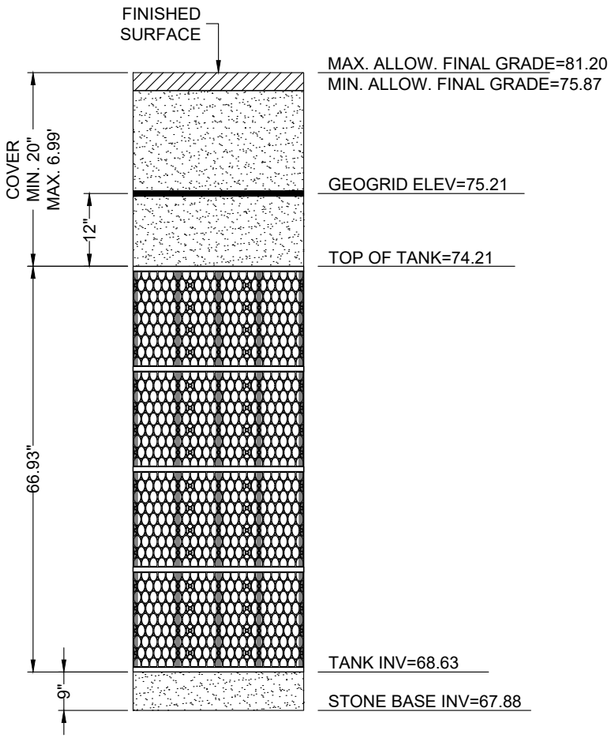
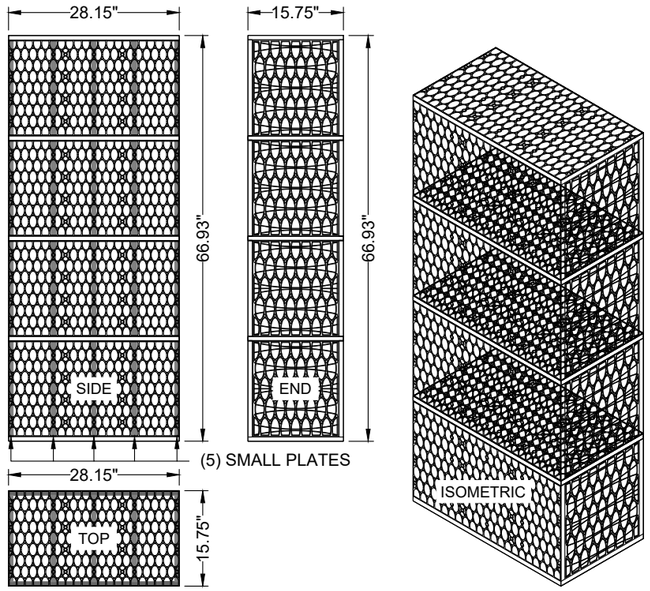
R-TANK^{HD} SYSTEM LAYOUT
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 3

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA



QUAD R-TANK^{HD} - ELEVATION



MODULE DATA

GEOMETRY:
LENGTH = 28.15 IN. (715 MM)
WIDTH = 15.75 IN. (400 MM)
HEIGHT = 66.93 IN. (1700 MM)
TANK VOLUME = 17.17 CF
STORAGE VOLUME = 16.31 CF
VOID INTERNAL VOLUME: 95%
VOID SURFACE AREA: 90%

LOAD RATING:
33.4 PSI, (MODULE ONLY)
HS20/HS25 - SEE SPEC FOR COVER REQUIREMENTS
MATERIAL:
100% RECYCLED POLYPROPYLENE
SMALL PLATES REQUIRED:
5/SEGMENT, 20/MODULE

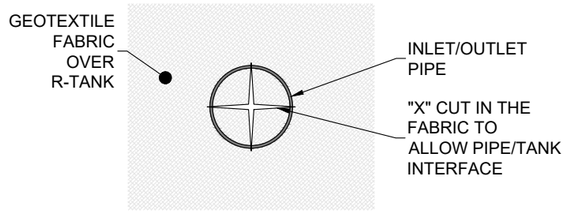
QUAD R-TANK^{HD} - MODULE DETAIL

R-TANK^{HD} QUANTITIES	
R-TANK^{HD} MODULE TYPE	QUAD
# OF QUAD R-TANKS	3,359
TOTAL SYSTEM STORAGE	62,623 CF
R-TANK STORAGE VOLUME	54,785 CF
STONE STORAGE VOLUME (40% VOID RATIO)	7,838 CF
STONE BED FOOTPRINT	11,317 SF
STONE QUANTITY	935 CY
TENCATE MIRAFI 180N NON-WOVEN TANK WRAP	26,865 SF (2,985 SY)
30 MIL. GEOMEMBRANE LINER EXCAVATION WRAP	30,209 SF (3,357 SY)
TENCATE MIRAFI 1100N NON-WOVEN LINER PROTECTION	60,418 SF (6,713 SY)
NAUE SECUGRID 30/30 GEOGRID	14,765 SF (1,641 SY)
12" MAINTENANCE PORTS	5
12" PIPE BOOTS	2
24" PIPE BOOTS	1
TRASHGUARD PLUS UNITS (RECOMMENDED)	2
NOTE: STONE QUANTITY INCLUDES 12" OF COVER AND 9" OF BASE.	
NOTE: GEOTEXTILE / LINER QUANTITIES INCLUDE A 15% WASTE FACTOR.	

NOTE:
30 MIL. GEOMEMBRANE LINER SHALL BE ULTRAVIOLET (UV) LIGHT RESISTANT.

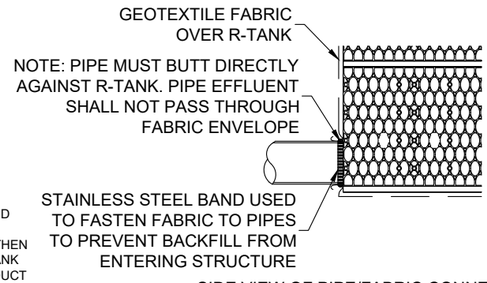
NOTES:
1. DEAD STORAGE VOLUME FROM ELEVATION 67.88 TO 68.38 = 2,263 CF
2. LIVE STORAGE VOLUME FROM ELEVATION 68.38 TO 75.21 = 62,623 CF
3. ONLY 3" OF BASE STONE INCLUDED IN LIVE STORAGE VOLUME.

CUT AN "X" IN THE FABRIC ENVELOPE THAT IS SLIGHTLY LARGER THAN THE PIPE. PULL THE FABRIC FLAPS AROUND THE PIPE, AND SEAL WITH A STAINLESS STEEL BAND.

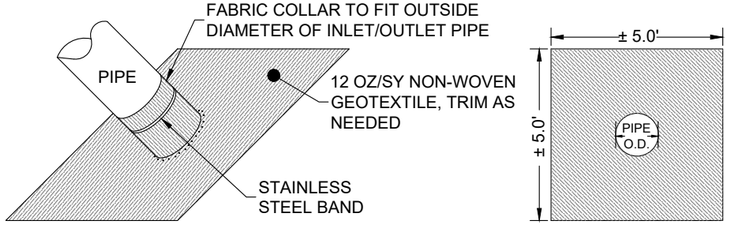


END VIEW OF PIPE/FABRIC CONNECTION

AFTER TANK WRAP IS SECURED TO PIPE, SLIDE BOOT AGAINST R-TANK AND SECURE WITH SECOND STAINLESS STEEL BAND, THEN ATTACH BOOT FLAP TO TANK ENVELOPE FABRIC WITH DUCT TAPE OR OTHER ADHESIVE.

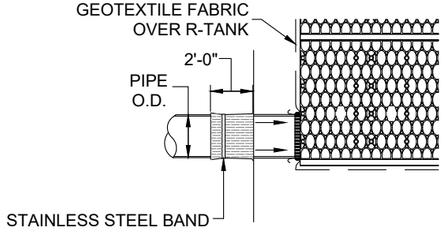


SIDE VIEW OF PIPE/FABRIC CONNECTION



GEOTEXTILE BOOT

FRONT VIEW OF GEOTEXTILE BOOT



SIDE VIEW OF GEOTEXTILE BOOT

R-TANK^{HD} TYPICAL TANK INLET/OUTLET W/ GEOTEXTILE PIPE BOOT DETAIL

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

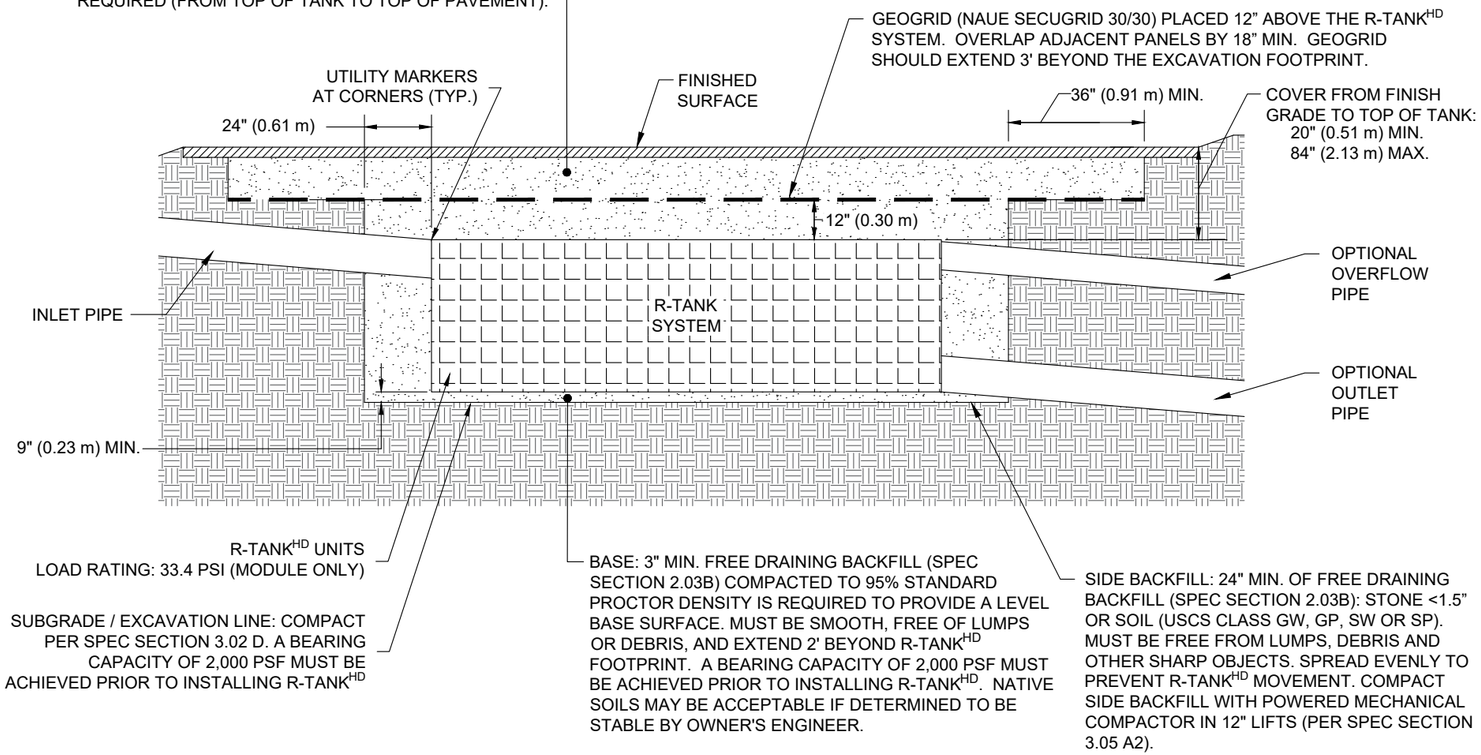
FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^{HD} SYSTEM DETAILS
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 3

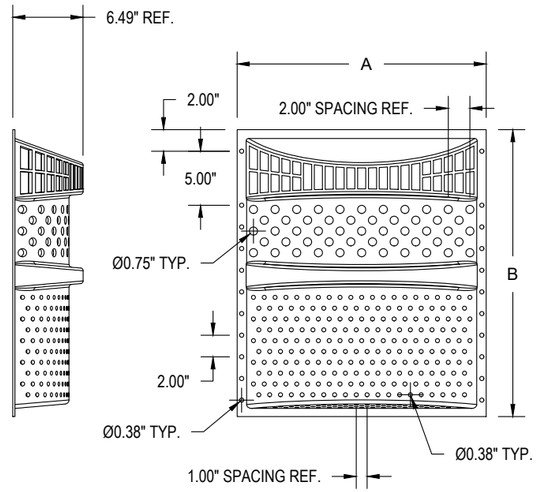
DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA

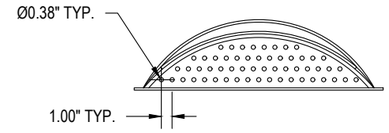
TOTAL COVER: 20" MINIMUM AND 84" MAXIMUM. FIRST 12" MUST BE FREE DRAINING BACKFILL (SPEC SECTION 2.03B): STONE <1.5" OR SOIL (USCS CLASS GW, GP, SW OR SP). ADDITIONAL FILL MAY BE STRUCTURAL FILL (SPEC SECTION 2.03C): STONE OR SOIL (USCS CLASS SM, SP, SW, GM, GP OR GW) WITH MAX CLAY CONTENT<10%, MAX 25% PASSING NO. 200 SIEVE, AND MAX PLASTICITY INDEX OF 4. A MIN. 12" COVER MUST BE MAINTAINED BETWEEN BACKFILL EQUIPMENT AND THE TOP OF THE R-TANK™ SYSTEM AT ALL TIMES. TOTAL HEIGHT OF TOP BACKFILL SHOULD NOT EXCEED 7'. CONTACT ACF WEST IF MORE THAN 7' OR LESS THAN 20" OF TOP BACKFILL IS REQUIRED (FROM TOP OF TANK TO TOP OF PAVEMENT).

NOTES:
1. FOR COMPLETE MODULE DATA, SEE APPROPRIATE R-TANK^{HD} MODULE SHEET .
2. INSTALLATIONS PER THIS DETAIL MEET GUIDELINES OF HL-93 LOADING PER THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, CUSTOMARY U.S. UNITS, 7TH EDITION, 2014 WITH 2015 AND 2016 INTERIM REVISIONS.
3. PRE-TREATMENT STRUCTURES NOT SHOWN.
4. FOR INFILTRATION APPLICATIONS, GEOTEXTILE ENVELOPING R-TANK SHALL BE ACF M200 (PER SPEC SECTION 2.02A) AND BASE SHALL BE 4" MIN. UNCOMPACTED FREE DRAINING BACKFILL (SPEC SECTION 2.03A) TO PROVIDE A LEVEL BASE. SURFACE MUST BE SMOOTH, FREE OF LUMPS OR DEBRIS, AND EXTEND 2' BEYOND R-TANK^{HD} FOOTPRINT.



R-TANK^{HD} & HS-20 LOADS - SECTION VIEW





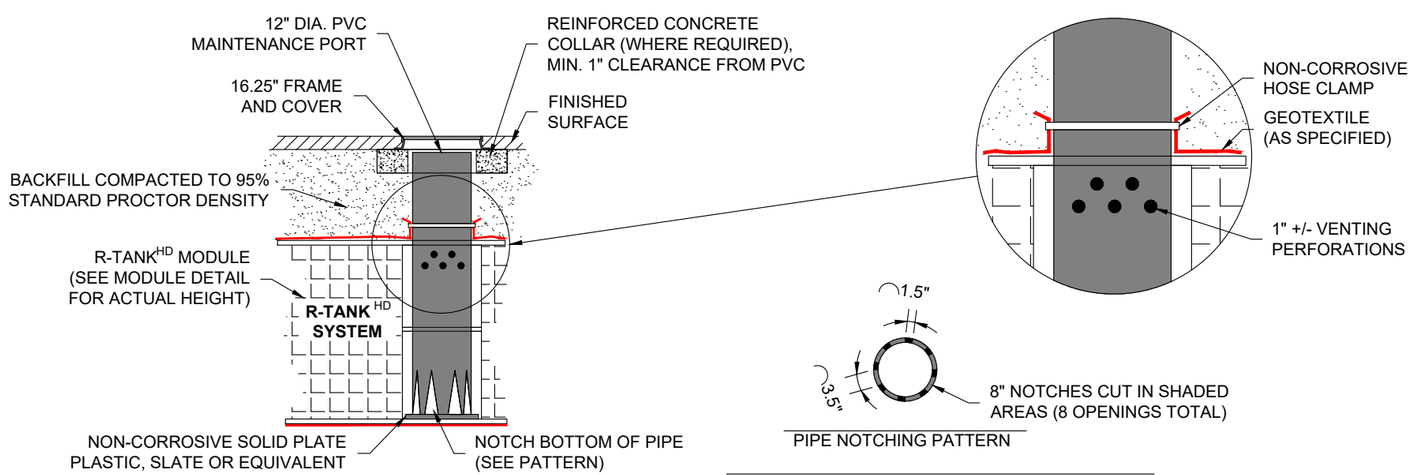
SIZE	A	B
23" x 24"	23"	26.51"
28" x 30"	28"	33.15"
34" x 36"	34"	38.69"

±0.25" TOLERANCE ON DIMENSIONS

NOTE:
TRASHGUARD PLUS UNITS ARE RECOMMENDED TO BE INSTALLED IN ALL CATCH BASINS DIRECTLY CONNECTED UPSTREAM OF THE R-TANK SYSTEM.

TRASHGUARD PLUS PRETREATMENT DETAIL

NOTES
1. THIS PORT IS USED TO PUMP WATER INTO THE SYSTEM AND RE-SUSPEND ACCUMULATED SEDIMENT SO THAT IT MAY BE PUMPED OUT.
2. MINIMUM REQUIRED MAINTENANCE INCLUDES A QUARTERLY INSPECTION DURING THE FIRST YEAR OF OPERATION AND A YEARLY INSPECTION THEREAFTER. FLUSH AS NEEDED.
3. R-TANK^{HD}, R-TANK^{SD}, R-TANK^{UD} AND R-TANK^{XD} MAY BE USED IN TRAFFIC APPLICATIONS.
4. SEE TRAFFIC LOADING DETAIL FOR MINIMUM & MAXIMUM COVER REQUIREMENTS.
5. IF MAINTENANCE PORT IS LOCATED IN A NON-TRAFFIC AREA, A PLASTIC CAP CAN BE USED IN LIEU OF A FRAME AND COVER WITH CONCRETE COLLAR.



PIPE NOTCHING PATTERN

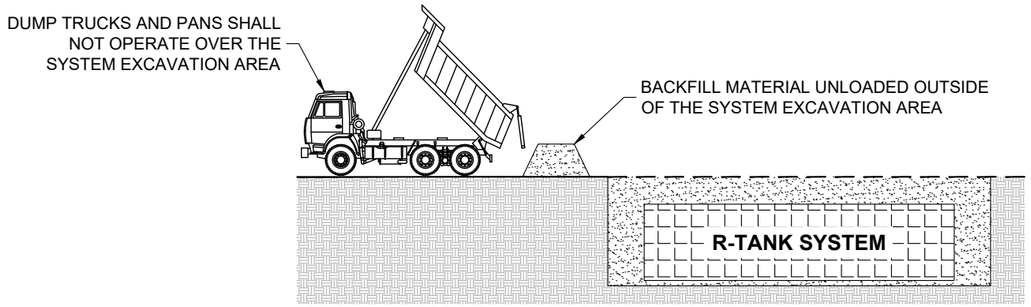
R-TANK^{HD} TYPICAL MAINTENANCE PORT

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^{HD} SYSTEM DETAILS
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 3

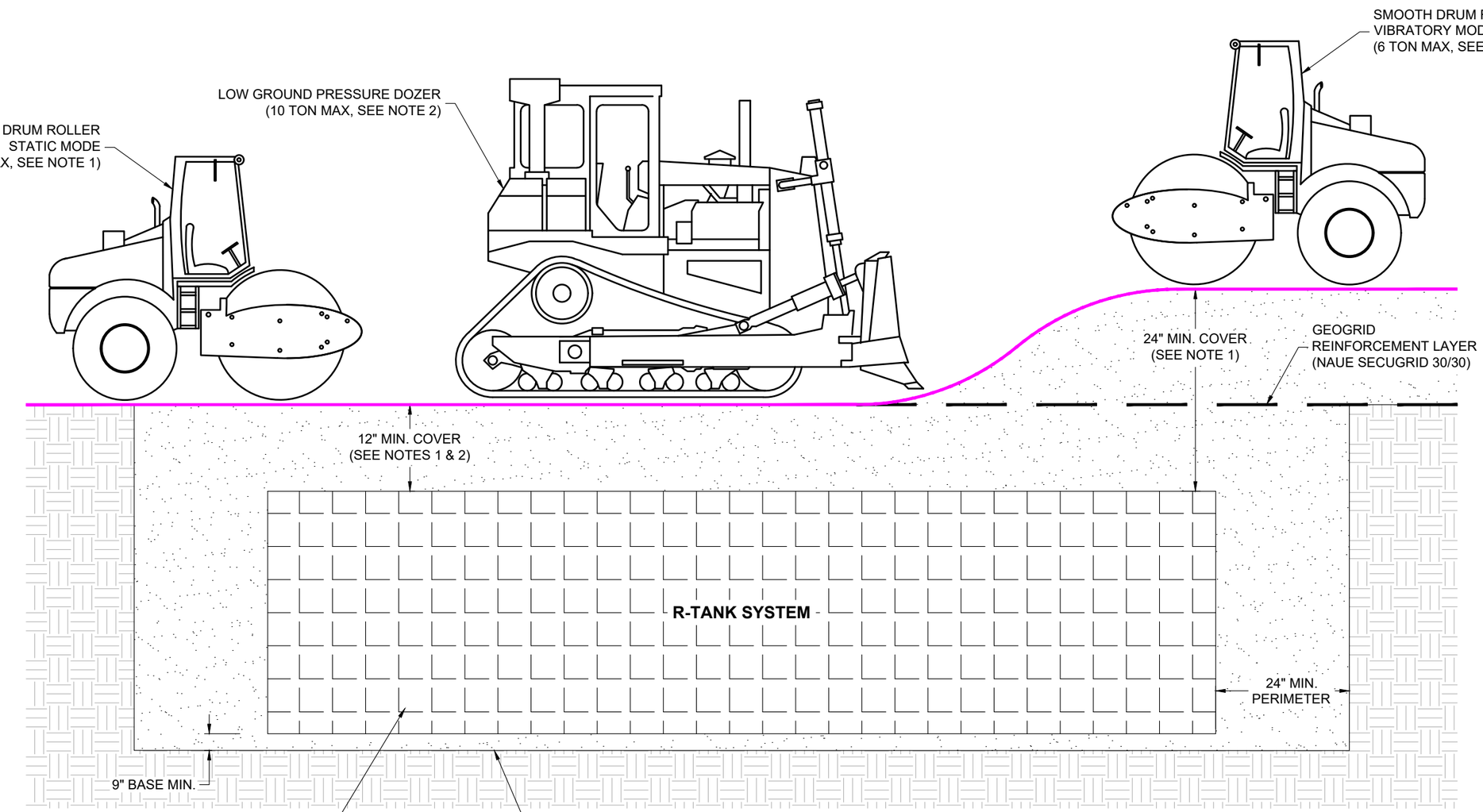
DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA
SHEET NO.: 4 of 6



DUMP TRUCK DETAIL (SEE NOTE 3)

NOTES:

1. FOLLOWING PLACEMENT OF SIDE BACKFILL, A UNIFORM 12" LIFT OF THE FREELY DRAINING MATERIAL (SPEC SECTION 2.03 B2) SHALL BE PLACED OVER THE R-TANK AND LIGHTLY COMPACTED USING A WALK-BEHIND TRENCH ROLLER. ALTERNATELY, A ROLLER (MAXIMUM GROSS VEHICLE WEIGHT OF 6 TONS) MAY BE USED. ROLLER MUST REMAIN IN STATIC MODE UNTIL A MINIMUM OF 24" OF COVER HAS BEEN PLACED OVER THE MODULES. SHEEP FOOT ROLLERS SHOULD NOT BE USED. **SPEC SECTION 3.05 A5**
2. ONLY LOW PRESSURE TIRE OR TRACK VEHICLES (LESS THAN 7 PSI AND OPERATING WEIGHT OF LESS THAN 20,000 LBS) SHALL BE OPERATED OVER THE R-TANK SYSTEM DURING CONSTRUCTION. **SPEC SECTION 3.05 A5**
3. DUMP TRUCKS AND PANS SHALL NOT BE OPERATED WITHIN THE R-TANK SYSTEM AT ANY TIME. WHERE NECESSARY, THE HEAVY EQUIPMENT SHOULD UNLOAD IN AN AREA ADJACENT TO THE R-TANK SYSTEM AND THE MATERIAL SHOULD BE MOVED OVER THE SYSTEM WITH TRACKED EQUIPMENT. **SPEC SECTION 3.05 A5**
4. ENSURE THAT ALL UNRELATED CONSTRUCTION TRAFFIC IS KEPT AWAY FROM THE LIMITS OF EXCAVATION UNTIL THE PROJECT IS COMPLETE AND FINAL SURFACE MATERIALS ARE IN PLACE. NO NON-INSTALLATION RELATED LOADING SHOULD BE ALLOWED OVER THE R-TANK SYSTEM UNTIL THE FINAL DESIGN SECTION HAS BEEN CONSTRUCTED (INCLUDING PAVEMENT). **SPEC SECTION 3.05 B**
5. SEE R-TANK INSTALLATION GUIDE OR CONTACT YOUR LOCAL ACF WEST REPRESENTATIVE FOR ADDITIONAL INFORMATION.



CONSTRUCTION EQUIPMENT COVER DETAIL - VEHICULAR TRAFFIC

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
ACF WEST, 1-800-423-4567, www.acfwest.com

R-TANK^HD CONSTRUCTION EQUIPMENT COVER DETAIL
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 3

DRAWN BY: EDQ
DATE: 09/28/2023
ACF WEST PROJECT NUMBER: 23-004WA
SHEET NO.: 5 of 6

R-TANK SPECIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, technical specification and general provisions of the Contract as modified herein apply to this section.

1.02 DESCRIPTION OF WORK INCLUDED

A. Provide excavation and base preparation per geotechnical engineer's recommendations and/or as shown on the design drawings, to provide adequate support for project design loads and safety from excavation sidewall collapse. Excavations shall be in accordance with the owner's and OSHA requirements.

B. Provide and install R-TankLD/, R-TankHD/, R-TankSD/, or R-TankU/D/ system (hereafter called R-Tank) and all related products including fill materials, geotextiles, geogrids, inlet and outlet pipe with connections per the manufacturer's installation guidelines provided in this section.

C. Provide and construct the cover of the R-Tank system including; stone backfill, structural fill cover, and pavement section as specified.

D. Protect R-Tank system from construction traffic after installation until completion of all construction activity in the installation area.

1.03 QUALITY CONTROL

A. All materials shall be manufactured in ISO certified facilities.

B. Installation Contractor shall demonstrate the following experience:

1. A minimum of three R-Tank or equivalent projects completed within 2 years; and,
2. A minimum of 25,000 cubic feet of storage volume completed within 2 years.
3. Contractor experience requirement may be waived if the manufacturer's representative provides on-site training and review during construction.

C. Installation Personnel: Performed only by skilled workers with satisfactory record of performance on bulk earthworks, pipe, chamber, or pond/landfill construction projects of comparable size and quality.

D. Contractor must have manufacturer's representative available for site review if requested by Owner.

1.04 SUBMITTALS

A. Submit proposed R-Tank layout drawings. Drawings shall include typical section details as well as the required base elevation of stone and tanks, minimum cover requirements and tank configuration.

B. Submit manufacturer's product data, including compressive strength and unit weight.

C. Submit manufacturer's installation instructions.

D. Submit R-Tank sample for review. Reviewed and accepted samples will be returned to the Contractor.

E. Submit material certificates for geotextile, geogrid, base course and backfill materials.

F. Submit required experience and personnel requirements as specified in Section 1.03.

G. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data that meets or exceeds criteria in Table 2.01 B.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect R-Tank and other materials from damage during delivery, and store UV sensitive materials under tarp to protect from sunlight when time from delivery to installation exceeds two weeks. Storage of materials should be on smooth surfaces, free from dirt, mud and debris.

B. Handling is to be performed with equipment appropriate to the materials and site conditions, and may include hand, handcart, forklifts, extension lifts, etc.

C. Cold weather:

1. Care must be taken when handling plastics when air temperature is 40 degrees or below as plastic becomes brittle.
2. Do not use frozen materials or materials mixed or coated with ice or frost.
3. Do not build on frozen ground or wet, saturated or muddy subgrade.

1.06 PREINSTALLATION CONFERENCE.

A. Prior to the start of the installation, a preinstallation conference shall occur with the representatives from the design team, the general contractor, the excavation contractor, the R-Tank installation contractor, and the manufacturer's representative.

1.07 PROJECT CONDITIONS

A. Coordinate installation for the R-Tank system with other on-site activities to eliminate all non-installation related construction traffic over the completed R-Tank system. No loads heavier than the design loads shall be allowed over the system, and in no case shall loads higher than a standard AASHTO HS20 (or HS25, depending on design criteria) load be allowed on the system at any time.

B. Protect adjacent work from damage during R-Tank system installation.

C. All pre-treatment systems to remove debris and heavy sediments must be in place and functional prior to operation of the R-Tank system. Additional pretreatment measures may be needed if unit is operational during construction due to increased sediment loads.

D. Contractor is responsible for any damage to the system during construction.

PART 2 - PRODUCTS

2.01 R-TANK UNITS

A. R-Tank - Injection molded plastic tank plates assembled to form a 95% void modular structure of predesigned height (custom for each project).

B. R-Tank units shall meet the following Physical & Chemical Characteristics:

PROPERTY	DESCRIPTION	R-Tank^{LD} VALUE	R-Tank^{HD} VALUE	R-Tank^{SD} VALUE	R-Tank^{UD} VALUE
Void Area	Volume available for water storage	95%	95%	95%	95%
Surface Void Area	Percentage of exterior available for infiltration	90%	90%	90%	90%
Vertical Compressive Strength	ASTM D 2412 / ASTM F 2418	30.0 psi	33.4 psi	42.9 psi	134.2 psi
Lateral Compressive Strength	ASTM D 2412 / ASTM F 2418	20.0 psi	22.4 psi	28.9 psi	N/A
HS-20 Minimum Cover	Cover required to support HS-20 loads	N/A	20"	18"	12" (STONE BACKFILL)
HS-25 Minimum Cover	Cover required to support HS-25 loads	N/A	24"	19"	15" (STONE BACKFILL)
Maximum Cover	Maximum allowable cover depth	3 feet	< 7 feet	< 10 feet	5 feet
Unit Weight	Weight of plastic per cubic foot of tank	3.29 lbs / cf	3.62 lbs/cf	3.96 lbs / cf	4.33 lbs / cf
Rib Thickness	Thickness of load-bearing members	0.18 inches	0.18 inches	0.18 inches	N/A
Service Temperature	Safe temperature range for use	-14 – 167° F	-14 – 167° F	-14 – 167° F	-14 – 167° F

C. Supplier: ACF West 15540 Woodinville-Redmond Rd., Woodinville, Washington 98072, (425) 415-6115, www.acfwest.com

2.02 GEOSYNTHETICS

A. Geotextile. A geotextile envelope is required to prevent backfill material from entering the R-Tank modules.

1. Standard Application: The standard geotextile shall be an 8 oz per square yard nonwoven geotextile (TenCate Mirafi 180N or equivalent).
2. Infiltration Applications: When water must infiltrate/exfiltrate through the geotextile as a function of the system design, a woven monofilament (TenCate Mirafi FW402 or equivalent) shall be used.

B. Geogrid. For installations subject to traffic loads and/or when required by project plans, install geogrid (Naue Secugrid 30/30 or equivalent) to reinforce backfill above the R-Tank system. Geogrid is not always required for R-TankUD/ installations, and is often not required for non-traffic load applications.

2.03 BACKFILL & COVER MATERIALS

A. Bedding Materials: Stone (angular and smaller than 1.5" in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System) shall be used below the R-Tank system (3" minimum). Material must be free from lumps, debris, and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation. For infiltration applications bedding material shall be free draining.

B. Side and Top Backfill: Material must be free from lumps, debris and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

1. Traffic Applications - Free draining material shall be used adjacent to (24" minimum) and above (for the first 12") the R-Tank system.

a. For HD, and SD modules, backfill materials shall be free draining stone (angular and smaller than 1.5" in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System).

b. For UD modules with less than 14" of top cover, backfill materials shall be free draining stone (angular and smaller than 1.5" in diameter). The use of soil backfill on the sides and top of the UD module is not permitted unless the modules are installed outside of traffic areas or with cover depths of 14" or more. Top backfill material (from top of module to bottom of pavement base or 12" maximum) must be consistent with side backfill.

2. Non-Traffic / Green Space Applications - For all R-Tank modules installed in green spaces and not subjected to vehicular loads, backfill materials may either follow the guidelines for Traffic Applications above, or the top backfill layer (12" minimum) may consist of AASHTO #57 stone blended with 30-40% (by volume) topsoil to aid in establishing vegetation.

C. Additional Cover Materials: Structural Fill shall consist of granular materials meeting the gradational requirements of SM, SP, SW, GM, GP or GW as classified by the Unified Soil Classification System. Structural fill shall have a maximum of 25 percent passing the No. 200 sieve, shall have a maximum clay content of 10 percent and a maximum Plasticity Index of 4. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

2.04 OTHER MATERIALS

A. Utility Marker: Install metallic tape at corners of R-Tank system to mark the area for future utility detection.

PART 3 - EXECUTION

3.01 ASSEMBLY OF R-TANK UNITS

A. Assembly of modules shall be performed in accordance with the R-Tank Installation Manual, Section 2.

3.02 LAYOUT AND EXCAVATION

A. Installer shall stake out, excavate, and prepare the subgrade area to the required plan grades and dimensions, ensuring that the excavation is at least 2 feet greater than R-Tank dimensions in each direction allowing for installation of geotextile filter fabric, R-Tank modules, and free draining backfill materials.

B. All excavations must be prepared with OSHA approved excavated sides and sufficient working space.

C. Protect partially completed installation against damage from other construction traffic by establishing a perimeter with high visibility construction tape, fencing, barricades, or other means until construction is complete.

D. Base of the excavation shall be uniform, level, and free of lumps or debris and soft or yielding subgrade areas. A minimum 2,000 pounds per square foot bearing capacity is required.

1. Standard Applications: Compact subgrade to a minimum of 95% of Standard Proctor (ASTM D698) density or as required by the Owner's engineer.
2. Infiltration Applications: Subgrade shall be prepared in accordance with the contract documents. Compaction of subgrade should not be performed in infiltration applications.

E. Unsuitable Soils or Conditions: All questions about the base of the excavation shall be directed to the owner's engineer, who will approve the subgrade conditions prior to placement of stone. The owner's engineer shall determine the required bearing capacity of the R-Tank subgrade; however in no case shall a bearing capacity of less than 2,000 pounds per square foot be provided.

1. If unsuitable soils are encountered at the subgrade, or if the subgrade is pumping or appears excessively soft, repair the area in accordance with contract documents and/or as directed by the owner's engineer.
2. If indications of the water table are observed during excavation, the engineer shall be contacted to provide recommendations.
3. Do not start installation of the R-Tank system until unsatisfactory subgrade conditions are corrected and the subgrade conditions are accepted by the owner's engineer.

3.03 PREPARATION OF BASE

A. Place a thin layer (3" unless otherwise specified) of bedding material (Section 2.03 A), over the subgrade to establish a level working platform for the R-Tank modules. Level to within ½" (+/- ¼") or as shown on the plans. Native subgrade soils or other materials may be used if determined to meet the requirements of 2.03 A and are accepted by the owner's engineer.

1. Standard Applications: Static roll or otherwise compact bedding materials until they are firm and unyielding.
2. Infiltration Applications: Bedding materials shall be prepared in accordance with the contract documents.

B. Outline the footprint of the R-Tank system on the excavation floor using spray paint or chalk line to ensure a 2' perimeter is available around the R-Tank system for proper installation and compaction of backfill.

3.04 INSTALLATION OF THE R-TANKS

A. Where a geotextile wrap is specified on the stone base, cut strips to length and install in excavation, removing wrinkles so material lays flat. Overlap geotextile a minimum 12" or as recommended by manufacturer. Use tape, special adhesives, sandbags or other ballast to secure overlaps. As geotextiles can be damaged by extreme heat, smoking is not permissible on/near the geotextile, and tools using a flame to tack the overlaps, such as propane torches, are prohibited.

B. Where an impervious liner (for containment) is specified, install the liner per manufacturer's recommendations and the contract documents. The R-Tank units shall be separated from impervious liner by a non-woven geotextile fabric installed accordance with Section 3.04A.

C. Install R-Tank modules by placing side by side, in accordance with the design drawings. No lateral connections are required. It is advisable to use a string line to form square corners and straight edges along the perimeter of the R-Tank system. The modules are to be oriented as per the design drawing with required depth as shown on plans.

1. For LD, HD, and SD installations, the large side plate of the tank should be placed on the perimeter of the system. This will typically require that the two ends of the tank area will have a row of tanks placed perpendicular to all other tanks. If this is not shown in the construction drawings, it is a simple field adjustment that will have minimal effect on the overall system footprint. Refer to R-Tank Installation Guide for more details
2. For UD installations, there is no perpendicular end row required.

D. Wrap the R-Tank top and sides in specified geotextile. Cut strips of geotextile so that it will cover the sides and top, encapsulating the entire system to prevent backfill entry into the system. Overlap geotextile 12" or as recommended by manufacturer. Take great care to avoid damage to geotextile (and, if specified, impervious liner) during placement.

E. Identify locations of inlet, outlet and any other penetrations of the geotextile (and optional liner). These connections should be installed flush (butted up to the R-Tank) and the geotextile fabric shall be cut to enable hydraulic continuity between the connections and the R-Tank units. These connections shall be secured using pipe boots with stainless steel pipe clamps. Support pipe in trenches during backfill operations to prevent pipe from settling and damaging the geotextile, impervious liner (if specified) or pipe. Connecting pipes at 90 degree angles facilitates construction, unless otherwise specified. Ensure end of pipe is installed snug against R-Tank system.

F. Install Inspection and Maintenance Ports in locations noted on plans. At a minimum one maintenance port shall be installed within 10' of each inlet & outlet connection, and with a maximum spacing of one maintenance port for every 2,500 square feet. Install all ports as noted in the R-Tank Installation Guide.

G. If required, install ventilation pipes and vents as specified on drawings to provide ventilation for proper hydraulic performance. The number of pipes and vents will depend on the size of the system. Vents are often installed using a 90 degree elbow with PVC pipe into a landscaped area with 'U" bend or venting bollard to inhibit the ingress of debris. A ground level concrete or steel cover can be used.

3.05 BACKFILLING OF THE R-TANK UNITS

A. Backfill and fill with recommended materials as follows:

1. Place freely draining backfill materials (Section 2.03 B) around the perimeter in lifts with a maximum thickness of 12". Each lift shall be placed around the entire perimeter such that each lift is no more than 24" higher than the side backfill along any other location on the perimeter of the R-Tank system. No fill shall be placed over top of tanks until the side backfill has been completed.
2. Each lift shall be compacted at the specified moisture content to a minimum of 95% of the Standard Proctor Density until no further densification is observed (for self-compacting stone materials). The side lifts must be compacted with walk behind compaction equipment. Even when "self-compacting" backfill materials are selected, a walk behind vibratory compactor must be used.
3. Take care to ensure that the compaction process does not allow the machinery to come into contact with the modules due to the potential for damage to the geotextile and R-Tank units.
4. No compaction equipment is permissible to operate directly on the R-Tank modules.
5. Top Backfill: Only low pressure track vehicles shall be operated over the R-Tank system during construction. Dump Trucks and Pans shall not be operated within the R-Tank system footprint at any time. Heavy equipment should unload in an area adjacent to the R-Tank system and the material should be moved over the system using tracked equipment with an operating weight of less than 10 tons.
   a. Typical Applications: Install a 12" (or as shown on plans) lift of freely draining material (Section 2.03 B) over the R-Tank Units, maintaining 12" between equipment tracks and R-Tank System. Lightly compacted using a walk-behind trench roller. Alternately, a roller (maximum gross vehicle weight of 6 tons) may be used. Roller must remain in static mode until a minimum of 24" of cover has been placed over the modules. Sheep foot rollers should not be used.
   b. Shallow Applications (< 18" total cover): Install top backfill in accordance with plans.
6. If required, install a geogrid as shown on plans. Geogrid shall extend a minimum of 3 feet beyond the limits of the excavation wall.
7. Following placement and compaction of the initial cover, subsequent lifts of structural fill (Section 2.03 C) shall be placed at the specified moisture content and compacted to a minimum of 95% of the Standard Proctor Density and shall cover the entire footprint of the R-Tank system. During placement of fill above the system, unless otherwise specified, a uniform elevation of fill shall be maintained to within 12" across the footprint of the R-Tank system. Do not exceed maximum cover depths listed in Table 2.01 B.
8. Place additional layers of geotextile and/or geogrid at elevations as specified in the design details. Each layer of geosynthetic reinforcement placed above the R-Tank system shall extend a minimum of 3 feet beyond the limits of the excavation wall.

B. Ensure that all unrelated construction traffic is kept away from the limits of excavation until the project is complete and final surface materials are in place. No non-installation related loading should be allowed over the R-Tank system until the final design section has been constructed (including pavement).

C. Place surfacing materials, such as groundcovers (no large trees), or paving materials over the structure with care to avoid displacement of cover fill and damage to surrounding areas.

D. Backfill depth over R-Tank system must be within the limitations shown in the table in Section 2.01 B. If the total backfill depth does not comply with this table, contact engineer or manufacturer's representative for assistance.

3.06 MAINTENANCE REQUIREMENTS

A. A routine maintenance effort is required to ensure proper performance of the R-Tank system. The Maintenance program should be focused on pretreatment systems. Ensuring these structures are clean and functioning properly will reduce the risk of contamination of the R-Tank system and stormwater released from the site. Pre-treatment systems shall be inspected yearly, or as directed by the regulatory agency and by the manufacturer (for proprietary systems). Maintain as needed using acceptable practices or following manufacturer's guidelines (for proprietary systems).

B. All inlet pipes and Inspection and/or Maintenance Ports in the R-Tank system will need to be inspected for accumulation of sediments at least quarterly through the first year of operation and at least yearly thereafter.

C. If sediment has accumulated to the level noted in the R-Tank Maintenance Guide or beyond a level acceptable to the Owner's engineer, the R-Tank system should be flushed.

D. All inspection and maintenance activities should be performed in accordance with the R-Tank Operation, Inspection & Maintenance Manual.

HD TANK

ENGINEER OF RECORD TO REVIEW, APPROVE AND ENDORSE FINAL SITE SPECIFIC DESIGN.

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R-TANK SPECIFICATION
EAST TOWN CROSSING
PUYALLUP, WA
SITE DESIGNATION: R-TANK 3

DRAWN BY
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DATE
09/28/2023

ACF WEST PROJECT NUMBER
23-004WA

SHEET NO.
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