CONSTRUCTION PLAN:

Emerald Sky Dairy, LLC

Construction Drawings for
Proposed Runoff Collection and Waste Storage Facility Improvements

2487 County Road G
Emerald, WI 54013
Todd Tuls: (402) 366–0363

DIGGER'S HOTLINE
http:www.diggershotline.com

Call 3 Work Days
Before You Dig!
Toll Free
1–800–242–8511
or
811

N
W E
S

NOT TO
SCALE

LOCATION MAP

I hereby certify that this plan was prepared by me and that I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.

WISCONSIN
RONNIE WILLIAMS
#35284
AUGUSTA
WI
LICENSED PROFESSIONAL ENGINEER

To the best of my professional knowledge judgement, and belief this design and these construction plans meet the NRCS and WDNR standards listed on this sheet.

NOTICE TO LANDOWNERS AND CONTRACTORS REGARDING UTILITES:

No representation is made as to the existence or nonexistence of underground hazards. Prior to the start of construction the owners of utilities must be notified of the pending construction. You will be liable for damages resulting from construction activities. (Call Diggers Hotline)

CONSTRUCTION DRAWINGS AND SPECIFICATIONS ACCEPTANCE

I/We have reviewed and do accept the attached plans. I/We agree to have this project constructed in accordance with these construction plans, operation and maintenance and specifications and to notify all affected utility companies.

Signed:_____ Date:_____

WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI 54722
Ronnie Williams, PE WI #35284
Cell # (715) 829–3231

*Site Location Information:

Address:	2487 County Road G, Emerald, WI 54013
County:	St. Croix
Township:	Town of Emerald
Township:	30N
Range:	16W
Section:	22

NRCS Conservation Practice Standards:

313	Waste Storage Facility (1/14)
342	Critical Area Planting (1/13)
360	Waste Facility Closure (3/13)
382	Fence (1/14)
412	Grassed Waterway (8/15)
533	Pumping Plant (7/11)
560	Access Road (10/14)
561	Heavy Use Area (8/15)
606	Subsurface Drain (3/14)
634	Waste Transfer (1/14)

Construction Specifications:

(See Specifications Section For These Documents)
USDA–NRCS Wisconsin – 1. Clearing (5/12)
USDA–NRCS Wisconsin – 2. Excavation (5/12)
USDA–NRCS Wisconsin – 3. Earthfill (5/12)
USDA–NRCS Wisconsin – 4. Concrete (3/15)
USDA–NRCS Wisconsin – 5. Construction Site Pollution Control (5/12)
USDA–NRCS Wisconsin – 7. Mobilization and Demobilization (5/12)
USDA–NRCS Wisconsin – 8. Drainfill (5/12)
USDA–NRCS Wisconsin – 9. Rock RipRap (11/11)
USDA–NRCS Wisconsin – 10. Fences (3/15)
USDA–NRCS Wisconsin – 13. GeoTextiles (5/10)
USDA–NRCS Wisconsin – 14. Timber Fabrication and Installation (9/10)
USDA–NRCS Wisconsin – 15. Plastic Pipe Conduits (4/9)
USDA–NRCS Wisconsin – 24. Construction Surveys (5/12)
USDA–NRCS Wisconsin – 26. Topsoiling (5/12)
USDA–NRCS Wisconsin – 44. Corrugated Polyethylene Tubing (5/12)
USDA–NRCS Wisconsin – 202. Polyethylene Geomembrane Lining (9/12)
USDA–NRCS Wisconsin – 204. Earthfill for Waste Storage Facilities (10/12)
USDA–NRCS Wisconsin – 300. Clay Liner (3/15)

Relevant WDNR Conservation Practice Standards:

NR–213	Wisconsin DNR – Lining of Industrial Lagoons and Design of Storage Structures (7/15)
NR–243	Wisconsin DNR – Animal Feeding Operations (7/15)
1001	Wet Pond (10/7)
1052	Non–Channel Erosion Mat (8/03)
1053	Channel Erosion Mat (12/04)
1056	Silt Fence (3/06)
1057	Stone Tracking Pad and Tire Washing (8/03)
1059	Seeding for Construction Site Erosion Control (11/03)
1060	Storm Drain Inlet Protection for Construction Sites (7/14)
1061	Dewatering (4/07)
1062	Ditch Check (3/06)
1063	Sediment Trap (9/05)
1064	Sediment Basin (3/06)
1067	Temporary Grading Practices for Erosion Control (3/04)
1068	Dust Control on Construction Sites (3/04)

Construction Quality Assurance Plan

EMERALD SKY DAIRY, LLC
TOWN OF EMERALD
ST. CROIX COUNTY, WISCONSIN

Prepared by:
Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
715-829-3231

August, 2017

Table of Contents

Introduction

Williams Engineering Services, LLC (WES) has developed this Construction Quality Assurance Plan for the proposed additions to Emerald Sky Dairy, LLC facility, owned by Todd Tuls, located in St. Croix County, Wisconsin. The purpose of this plan is to detail the duties of all responsible parties and assure that all construction activities of all the dairy facilities components are constructed/installed in accordance to the construction designs and applicable standards.

Engineering

Williams Engineering Services, LLC (WES) and the principle engineer (Ronnie Williams, PE) is responsible for designing the dairy facility site layout and waste handling and storage system to meet applicable State and Local standards and tailored to the owner's need and specifications. If the dairy facility is not constructed according to the approved design, drawings and specifications, the engineer will not certify the construction.

Owner/Operator

The Owner (Todd Tuls) and the Operator (TJ Tuls) are in control of choosing contractors that are able to complete the tasks assigned to them. Upon awarding the bids to the contractors, all coordinating and scheduling shall be done between the owner and contractor and in communication with the engineer and other contractors. All contractors are directly responsible to the owner.

Contractors

The contractors that have been hired or awarded bids are required to install/construct all of the designed components as detailed in the construction plans and according to the approved specifications. Sub –contractors may be hired to complete work that the primary contractor or contractors are not able to complete. Any changes to the designs or specifications will have to be approved by the engineer prior to being changed.

Inspector/Surveyor

Personnel from Williams Engineering Services, LLC (WES) will be responsible for the inspection of the dairy facility construction. The inspector will make recommendations, observe and document all construction activities. General construction layout staking will be done by WES personnel. Requests for re-staking can be directed to WES personnel. Benchmarks and AutoCAD drawings will be provided on request.

Material Testing

All concrete and soil material testing will be performed by WES personnel on site and/or at the WES laboratory. All testing will be conducted according to ASTM standards and specifications. The results of testing will be supplied to the permitting agencies and the owner for review.

A. Inspection:

The primary field inspection for this project will be provided by Ronnie Williams, PE or personnel of Williams Engineering Services, LLC. This project will require certification by Ronnie Williams for compliance with NRCS and DNR practice standards and St. Croix County Zoning and Land Conservation requirements. All deviations from the design plan **MUST BE APPROVED** by the engineer, Ronnie Williams, **PRIOR** to being changed. Any significant plan changes may also require approval by the DNR and/or St. Croix County Land Conservation Department. Upon completion of the project as-built plans with any red-lines will be provided to the DNR and St. Croix County Zoning/LCD.

B. General:

This construction plan, together with the attached set of construction specifications, set forth the requirements for the installation of the waste transfer and storage facility and site grading for this facility. The construction specification packet shall be referenced during construction.

This project is designed according to the NRCS and DNR practice standards listed on the cover sheet.

The presence or absence of any below ground utilities must be documented in written form prior to construction.

C. Preconstruction Conference:

A preconstruction conference will be held. During the conference the construction plans, construction specifications, layout, required materials, required inspection & materials testing, installation requirements, safety precautions, utilities, and any information needing clarification by Williams Engineering Services, LLC will be discussed. Attendees should include representatives from DNR/St. Croix County, Contractors involved, Ronnie Williams, PE (Engineer), Todd Tuls (Owner), and TJ Tuls (Operator).

D. Material Requirements:

All materials intended to be used on this site shall be inspected to ensure that they conform to the requirements of the plan. Items include, but are not limited to PVC and HDPE pipe, steel reinforcement bar, PVC waterstop, hydrophilic waterstop sealants, concrete curing compound, concrete, granular and earth-fill materials, etc.

E. General Inspection:

1. Erosion Control: Erosion control practices shall be installed prior to conducting earth moving activities.
2. Excavation:

a) Remove all existing tree roots and other organic material as well as buried debris associated with prior land use of the construction site.

b) Strip topsoil from worksite and stockpile areas. Store stripped material in designated areas and protect from erosion by seeding the pile as well as installing other erosion control practices.

c) Check lines and grades as they are constructed and document that the over-excavation and stockpiling is proceeding as planned. On-site materials shall be mined as appropriate and stockpiled for future use.

3. Earth fill:
   a) Make certain that all organic matter is removed from areas receiving fill prior to placement of fill in accordance with NRCS Construction Specifications.
   b) Inspect and document the adequacy of earth fill materials and compaction. Make sure that the thickness of the loose fill lift is within limits as described in the earth fill construction specifications. Document compaction method, lift thickness, equipment type, number of passes, and type and quality of soil materials used.
   c) Determine need for wetting, drying, or mixing of fill material to satisfy moisture requirements related to proctor testing, etc.
   d) Check lines and grades as they are constructed and document that the system is installed as planned.

3. Re-Vegetation/Mulching:
   a) Check that the placement thickness and quality of topsoil is adequate for a viable seedbed.
   b) Verify that the proper species and quantities of grass seed are applied.
   c.) Check to ensure that all disturbed soil is seeded and mulched according to seeding sheet in the construction plan.

4. Fence/Gates:
   a) Make sure that a proper safety fence is installed as shown in the construction plan. Safety fence, and or gates are required around tanks, ponds, and any other structure that could pose a fall hazard. Fencing specifications must follow NRCS 382 and NRCS construction specification 10 in order to meet the DNR and County requirements.

5 Concrete Placement:
   a) All concrete subgrade, steel material and placement, wall tie break back depth and sealing, concrete consolidation and concrete curing shall be inspected.
   b) All concrete with waterstop requires continuous inspection by WES personnel.

6. Concrete Testing:
   Concrete testing shall be performed by Williams Engineering Services.

7. Manure Transfer/Pumping Systems:
   All manure transfer systems and/or plumbing shall be installed to meet NRCS 634 Construction Specification requirements.

8. Grassed Waterway and Diversion
   a.) Inspect waterway and diversion slope, width, and depth to ensure accordance with plan.
   b.) Verify proper slope transitions.
   c.) Verify proper seeding and mulching.

F. Construction Approval & Certification of Completion:

Construction approval and certification of completion will be provided by Ronnie Williams, PE of Williams Engineering Services, LLC upon verification that all requirements have been met.

PRE-CONSTRUCTION

_____ Verify that the landowner or contractor notified all utilities prior to construction. Document Diggers Hotline Ticket Number _____.

_____ Obtain copies of Permits, or documentation that permits are not required.

_____ Inspect Erosion Control Practices (silt fence, etc.) as required in the construction plan. Document proper installation with photographs and field book notations.

MATERIALS

_____ Manure Transfer Pipe Materials. Verify that pipe materials comply with Wisconsin Construction Specification 634. Obtain a material invoice with the required information, a tag from the material itself, or a digital photograph of the tag.

_____ Transfer Pipe Backfill. Verify gradation meets specifications. Record observations in the job book.

_____ Manure Transfer Pipe Connections. Verify liquid-tight connection of pipes. Record observations and pipe materials and/or sealants in the field book.

_____ Concrete Materials. Verify that the proposed mix design and all ingredients meet the requirements in Wisconsin Construction Specification 4. Attach material documentation.

_____ Reinforcing Steel Materials. Verify that the reinforcing steel is free of loose rust, oil, grease, paint, or other deleterious matter. Document markings or attach tags. Steel grade and size shall comply with construction plan.

_____ Curing Compound. White Pigmented meeting ASTM C309 Type 2 is typically used. Other materials may be used upon approval of the engineer. Document material and adequacy of coverage in field book.

_____ Concrete Chairs. Verify concrete bricks have minimum 3500 psi strength if used.

CONSTRUCTION-TANK INSTALLATION

_____ Stake The Location of the structure. Set Grades if necessary.

_____ Document That Poured Tanks Are Set At Proper Elevations. Inspect subgrade and reinforcement placement as well as concrete placement and consolidation. Record observations in field book. Take photographs.

_____ Document proper grating and/or fencing around structures.

CONSTRUCTION-CONCRETE AND REBAR

_____ Observe The Reinforcing Steel Placement. Verify correct overlap and spacing per plans. Verify forms will provide correct concrete thickness. Obtain photographs and/or record observations in the field book. Make sure reinforcing steel is >1.5 inches from any transfer pipe.

_____ The Inspector Must Be Present For The Concrete Placement With Waterstop. Collect batch tickets from loads, verify that material is the same as that which is certified.

_____ Verify concrete slump is between 2" and 5" as per the specifications. Water may only be added once and only at the beginning of the pour. Verify that the maximum gallons of water added is not exceeded. Collect cylinders for lab analysis.

_____ The concrete shall be discharged as closely as possible to its final position in the forms. Concrete shall not be dropped more than 5 feet or as per the specifications.

_____ Document method of concrete consolidation and spacing and effectiveness of waterstop vibration.

_____ Document that walls greater than 2' in height are vibrated.

_____ Document sealant type used for liquid-tight joints between existing and new concrete. Document dowel spacing and dowel length into existing concrete. Document sealant is placed sufficiently to protect rebar from corrosion. Document that hydrophilic sealant has sufficient concrete cover as required by the manufacturer.

_____ Curing compound shall be applied uniformly. Exposed concrete shall be kept continuously wet until curing compound is applied.

CONSTRUCTION-TRANSFER PIPE AND BACKFILL

_____ Document method of fill placement around tanks and transfer lines. Lift thickness, number of passes, and equipment used to compact lift if required shall be recorded. Check that the method used is in accordance with Table 1 of the Earth-fill Specification.

_____ Concreting in Cold Weather as discussed on pages 4-14 and 4-15 of WI Construction Specification 4 shall be documented by Williams Engineering Services in the following manner. Temperature data loggers shall be installed and maintained by WES during the duration of the project.

_____ One temperature data logger shall be installed at the job site which measures and records the on-site air temperatures at 1 minute intervals during the entire curing duration as defined in WI Const. Spec. 4.

_____ Three temperature data loggers shall be installed at the job site and in contact with the fresh concrete which shall measure and record the concrete temperature of each day's concrete placement at 1 minute intervals during the curing duration. Each day's concrete placement shall have three additional data loggers installed for the curing duration.

_____ One temperature data logger shall be installed at the job site which measures and records the inside temperature of the job site cooler which houses the concrete test cylinder samples.

_____ Insulation blankets and/or other insulating material and/or heating system as discussed in WI Construction Specification 4 shall be installed as soon as practicable after concrete placement in order to retain, maintain, and stabilize the curing conditions of the placed concrete.

_____ A representative of Williams Engineering Services shall indicate to the contractor when the curing duration has been completed and when the insulation/heating system may be removed.

Preconstruction Meeting

Waste Storage Facility, Manure Processing Facility,
Feed Pad & Waste Transfer

NAME	TITLE	ORGANIZATION	PHONE NUMBER

Plan in the Even of A Spill:

This contingency plan pertains to the spill of solid and liquid waste as well as contaminated runoff. Enact this plan if a spill occurs.

1. Manure spill on farmstead:
    - Stop the source of the leak or spill. Turn off all pumps/valves and clamp hoses or park tractor on hoses to stop flow.
    - Contain the spill by means of grading a shallow ridge to prevent entry to the downstream waterway. A tractor mounted back blade is available for this purpose.
    - Use pumps to recover and directly land apply on approved sites.
2. Manure spill on public road and/o right-of-way:
    - Stop the source of the leak or spill. Turn off all pumps/valves and clamp hoses.
    - Inform Wisconsin Hazardous Spill Line at 1-800-943-0003. Spill reporting is mandatory by state law.
    - Inform the local sheriff's, police, and/or Department of Transportation for traffic control.
    - Contain the spill in the road ditch before it can enter a stream or body of water by blocking downslope culverts and building dikes/ditches to divert or contain with a skid loader or a tractor mounted back blade.
    - Remove manure from the roadway and roadside with a skid loader or a tractor mounted back blade.
    - Use pumps to recover liquids and/or directly land apply on approved sites.
    - Document your actions.
3. When the maximum operating level is reached on any manure storage structure, manure shall be field applied or transferred to another storage location on the farm.
4. Be prepared to provide the following information:
    - Your name and contact information.
    - Farm address, location, and/or other pertinent identification information.
    - Nature of emergency (employee injury, fire, discharge of manure or hazardous materials, etc.)
    - Potential for manure or hazardous materials to reach surface waters or major field drains.
    - Current status of containment efforts.
    - Location(s) of hazardous/flammable materials and fire suppression equipment.

Plan if Waste Reaches Maximum Operating Level:

If liquid level reaches the maximum operating level (MOL) the landowner/operator will pump material from the structure to maintain an operating level below the maximum. The operator may land apply or transfer to another WSF that is below the MOL.

Utilities

All underground hazards and utilities both public and private must be investigated prior to the start of construction. Notification of affected utility companies is the responsibility of the landowner. A ticket number from Digger's Hotline shall be provided to the engineer prior to the start of the excavation. Digger's Hotline is a free service.

Sitework & Soils

Areas that will be under construction will have the topsoil stripped and stock piled for later use. Construction areas should be free of organics, damaging and unfrozen materials. Once the unsuitable material is removed, acceptable material confirmed by the inspector or engineer will be used. Structural fill must be compacted to 95% of the Standard Proctor Maximum Dry Density (SPMDD) and field density test will be conducted every 100ft of building pad length or in accordance with design drawings and specifications. All contaminated soils and organic matter shall be removed from the site prior to construction.

The clay liner for the HDPE lined ponds will be constructed out of material that meets the requirements in the design specifications. The soil shall be of organics and liner damaging materials such as rocks and stones according to Wisconsin Specification 204 (WI Spec 204). The 3 foot clay sub-liner material must be applied in lifts according to WI Spec 204 and the soil material shall have 40 percent or more passing a #200 mesh sieve. The plasticity index must be greater than 7. WES personnel will be on site during the placement of the liner and will conduct soil material and compaction testing as required by NRCS 313 and Wisconsin Construction Specification 300.

Any trench work over a depth of 5 feet must be excavated at 1 to 1 side slopes to insure safe working conditions. The contractor is responsible for safe working conditions.

Transfer Pipe

Gravity and pressurized pipes will be used to transfer manure. All pressurized manure transfer pipe shall be AWWA C-905 PVC, D1785 Sch. 40 PVC, PE D714 or D2241 SDR 21 PVC pipes. Pipe elbows shall be compatible with transfer pipe and be of equal pressure rating or greater than that of the pipe. The transfer pipe materials shall be approved by the engineer prior to use. The transfer pipes are to be firmly and uniformly bedded throughout the entire length. Bells are to be located upstream if possible and material excavated around bell joints to prevent pipe being supported by the bells. It is recommended to use sand backfill (see pipe installation sheet) around the pipes to facilitate good compaction and pipe support. Any bends in the piping must have 1 cubic foot of concrete thrust block which must be inspected prior to back filling. All pressurized lines shall be pressure tested per WI NRCS – 634.

Concrete Mix & Concrete Placement

An approved concrete mix in accordance with Wisconsin Construction Specification 4 must be used at all times. The concrete company shall supply batch tickets to the inspector. Contractors must supply documentation that the mix design meets requirements to the engineer.

All concrete that includes waterstop joints will be continuously inspected by WES personnel. At least a 24 hour notice of the concrete placement should be given to the engineer or inspector.

Concrete mixtures, placement, and cold weather concrete placement protocols shall follow WI-NRCS Construction Specification #4 - Concrete. LeakMaster LV-1, Hydrotite rope, or equal hydrophilic sealants shall be used to seal joints between pipe and concrete surfaces and some concrete/concrete joints. All exposed concrete shall be cured with an approved curing compound shortly after concrete is stable enough to walk on.

All concrete testing will be performed by WES personnel in accordance with ASTM standards. Test such as slump, air entrainment, temperature and compressive strength will be done. Any concrete loads not in compliance are subjected to rejection.

Rebar & Forms

Rebar grade and spacing specified scenarios according to joint spacing specified in the construction plan must be used at all times. All rebar must meet 60,000 psi and must verify this by supplying an invoice to the inspector or engineer. The rebar placement and spacing must be inspected before placement of concrete to insure compliance.

All formwork must be supported in a manner that it doesn't allow blow outs or curving. The forms shall have clean surfaces. The contractor must verify that the forms are set to the correct elevations specified in the construction plan.

All forms must be kept on for a minimum of 24 hours or until specified by the inspector. Any defects such as honeycombing must be repaired.

Walls for waste storage structures shall have form ties that break back ½" below the concrete surface and tie holes shall be sealed with epoxy prior to curing compound application.

HDPE Liners

The HDPE liner must meet the specification in Wisconsin Construction Specification 202 and the installing company must provide the proposed layout to the landowner and engineer. Inspection of the drain tile, venting tiles and subgrade must be inspected prior to any liner placement. The subgrade must be free of damaging material such as rocks and stones that could puncture the HDPE liner. The installing company must provide test results of performed tests according to WSC 202. WES personnel will provide continuous inspection of

the HDPE liner and components installation as well as continuous inspection of all construction activities that could inadvertently damage the liner.

Fences & Gates

Minimum safety fencing/railings/signs and covers shall be installed around any manure drop structures, manholes, or reception pit structures. Fencing is required around the manure storage basins.

Erosion & Sediment Controls

This project will disturb approximately 24 of the 86 acres of the Emerald Sky Dairy, LLC parcel. DNR erosion permits are required. All erosion control measures must be installed before any site work occurs. During all phases of construction, erosion and sediment controls need to be implemented to avoid discharge sediment-laden runoff from the proposed dairy. Best Management Practices (BMPs) shall be applied in any applicable situation. Erosion control devices that may be utilized include silt fence, vehicle tracking pads, erosion mats, culvert sediment traps, rock check dams, straw bale ditch checks and seeding. All control devices must be maintained until all disturbed areas of the proposed dairy is completely stabilized and vegetated areas have sufficient growth to be able to resist erosion. Coverage of at least 70 percent is required to be able to submit a Notice of Termination (NOT) Form to the WNDR. Upon approval, all temporary erosion and sediment control devices shall be removed.

Proper Internal Vibration

- Increases compressive strength and bond between concrete and rebar and decreases concrete permeability
- Decreases cold joints, honeycombing, excessive entrapped air, and segregation
- Causes concrete within a circular field of action to act like a liquid

How to Vibrate

- Insert vibrator vertically, allowing it to penetrate rapidly to the bottom of the lift and at least 6 inches into the previous lift
- Hold it at the bottom of lift for 5 to 15 seconds
- Pull vibrator up at a rate of 15 seconds for a 4-foot lift, or about 3 inches per second

Spacing Tips

- Space out the Insertion of the vibrator so the fields of action overlap
- Watch the concrete to determine the vibrator's field of action
- High-powered vibrators and high slump concrete have larger fields of action
- Rule of thumb: the radius of the field of action is four times the vibrator's head diameter. Therefore, for a 1-inch pencil vibrator, the diameter of the field of action is about 8 inches. Accordingly, in ICF typically you should vibrate every cell between webs.

Stop Vibrating when:

- The concrete surface takes on a sheen
- Large air bubbles no longer escape
- You hear the vibrator change pitch or tone
- You feel a change in vibrator action

Vibrating Don'ts

- Don't let a vibrator run very long outside of the concrete – it will overheat and fail
- Don't force or push a vibrator into concrete; it won't remain vertical and may get caught in the reinforcing steel
- Don't start a job without a spare vibrator

Revibrating Concrete

Revibrating concrete momentarily liquifies the concrete again. The primary chemical process that occurs in the first 2 hours after concrete is placed is the formation of calcium hydroxide, which typically makes up 15 to 25 percent of ordinary portland cement concrete. The other major product of hydration is calcium silicate hydrate, which usually makes up about 50 percent of ordinary portland cement concrete and gives the concrete its hardness and durability. Formation of calcium silicate hydrate begins in earnest only after several hours have elapsed.

Somewhere in that process, the concrete reaches initial set, defined as a compressive strength of 500 psi. After initial set, formation of the more brittle, weaker calcium hydroxide continues but

falls behind the calcium silicate hydrate formation, which accelerates dramatically between initial set and final set, defined as 4000 psi. (See "time of setting" in ASTM C125, which covers concrete terminology.)

When revibration occurs after the initial set, it breaks down some of the calcium hydroxide that has already been formed. That allows freshly placed concrete adjacent to the revibrated concrete to join with it, rather than introducing a construction joint, and it again becomes a monolithic concrete structure.

Revibration of concrete has been an accepted construction method for more than 50 years. An article from CONCRETE CONSTRUCTION in February 1959 provided an overview of the practice and concluded by saying: "Concrete will benefit from revibration at any time provided the concrete is sufficiently plastic to permit the running vibrator to sink of its own weight." Although we've learned more since then about what is going on in concrete as it hardens, the benefits of revibration have not changed. *Source: Concrete Construction, March 2004*

Concrete Testing

Concrete Inspection shall include the following testing schedule. The test results shall be recorded in the field log and be submitted with the As-Built record drawing as part of the construction certification report.

Concrete testing will be performed by certified technicians of Williams Engineering Services, LLC. The concrete contractor shall notify WES of all scheduled concrete placements so that they may be inspected and materials tested. Adequate notice period of 24 hours or as discussed with the engineer is expected prior to each concrete placement.

The tests listed below shall be performed at a minimum frequency of one sample or test for each 150 cubic yards (CY) of concrete, or portion thereof, as recommended by the American Society for Testing and Materials (ASTM) Method C-94 "Specification for Ready-Mixed Concrete."

Sampling and testing should also include the following:

1. The making and curing of concrete test specimens in the field shall be performed in accordance with ASTM C-31.
2. Sampling according to ASTM C-172, "Method of Sampling Freshly Mixed Concrete".
3. Slump Test according to ASTM C-143, "Test for Slump of Hydraulic Cement Concrete".
4. Compressive Strength according to ASTM C-39, "Test for Compressive Strength of Cylindrical Concrete Specimens." One test set will consist of the average test strength of two (2) sample cylinders at 28 days and the test strength of one sample cylinder at 7 days. The 7 day sample is expected to break at 50% of the design strength, and the 28 day samples are expected to break at 100% of the design strength.
5. Concrete temperature shall be tested according to ASTM C-1064, "Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete".
6. Air Entrainment shall be tested as described below, and the type and dosage rate of air-entraining admixture or air-entraining cement must be indicated on the batch tickets.

Concrete that will be exposed to freezing and thawing or chemical attack shall have the air content of the concrete mix tested according to one of the following: ASTM C-231, "Test for Air Content of Freshly Mixed Concrete by the Pressure Method", ASTM C-173, "Test for Air Content of Freshly Mixed Concrete by the Volumetric Method", or ASTM C-138 "Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete".

Recommended Expanding Sealant Material For Use In Concrete

Expanding sealant materials can be used in projects where new concrete is being placed against existing concrete or for sealing pipe penetrations through concrete walls or slabs. The following materials have been tested and expand in the presence of manure. **All materials are to be applied in conformance with the manufacturer's requirements.**

LEAKMASTER LV-1 is recommended.

LEAKMASTER LV-1 by C. I. Kasei
The sealant is supplied in commonly available size caulking tubes. The applied material is sticky and stays in place on a clean surface. The material is to be applied to obtain a sealant cross section of 1/2 inches wide by 1/4 inch high. Allow 24 hours to cure prior to concrete placement.

HYDROTITE by Greenstreak
The sealant is supplied in a preformed strip. The minimum rectangular strip to use is 3/4 inches wide by 3/8 inches high. Non-horizontal applications require the use of an adhesive primer or concrete nails to hold the sealant strip in place. CJ-1020-2k is recommended for pipe applications.

SIKA SWELL by Sika
The sealant is supplied in a preformed strip or in a moisture-proof "sausage" which requires a special gun to apply. The minimum rectangular strip to use is 3/4 inches wide by 1/8 inch high. Non-horizontal applications require the use of an adhesive primer or concrete nails to hold the sealant strip in place.

The "sausage" applied material is sticky and stays in place on a clean surface. The minimum applied bead cross section is to be triangular 5/8 inches by 5/8 inches by 5/8 inches. .

ULTRA SEAL MC-2005T by Adeka

The sealant is supplied in a preformed strip with adhesive back. The minimum rectangular strip to use is 3/4 inches wide by 1/4 inch high.

SWELLSEAL by de neef CONCHEM, distributed by Vinylex Corp.
The sealant is supplied in a preformed strip or in a moisture-proof "sausage". The minimum rectangular strip to use is 3/4 inches wide by 1/8 inch high. Non-horizontal applications require the use of an adhesive primer or concrete nails to hold the sealant strip in place.

The "sausage" applied material is sticky and stays in place on a clean surface. The minimum applied bead cross section is to be triangular 5/8 inches by 5/8 inches.

In conditions where air temperatures cannot be maintained or are expected to be at or below 45 degrees, Hydrotite Rope shall be used in lieu of Leakmaster LV-1 due to curing requirements of Leakmaster LV-1.

Existing Waste Storage Facility
Abandonment Procedures & Construction Inspection Plan
NRCS 360 "Waste Facility Closure (3/13)"
Emerald Sky Dairy, LLC

NOTE: The process of removing contaminated soil from the existing waste storage structure and/or heifer lot collection tank shall be observed by Engineer, Ronnie Williams, PE or Senior Engineering Technician, Cody Overgard of Williams Engineering Services, LLC.

Emptying Of Pond

Manure shall be removed from the storage using traditional manure agitating, loading, and pumping equipment. Land spreading of the manure shall adhere to the following guidelines:

- Manure shall be applied at a rate that meets requirements of the NRCS 590 Standard and NR 243 approved field application areas.
- Manure shall not be applied to cropland that is located within a Surface Water Quality Management Area (SWQMA is an area within 300 feet from a perennial stream or 1,000 feet from a lake, pond, or flowage), unless incorporated within 72 hours. The maximum application rate within a SWQMA is 5,000 gals/acre. Subsequent applications may be made after waiting 7 days.
- Manure nutrients (NPK) and legume nutrient (N) shall be credited where applicable.
- Manure may not be spread on non-cropland areas (wetlands, non-harvested grasslands, grassed waterways) or on frozen or snow-covered crop ground within SWQMAs. Manure may not be applied within 50' or within 200' upslope of a well.
- Temporarily stacked manure must meet the requirements of Table 9 in the WI NRCS 313 Standard.
    - Remove as much manure as possible from the storage using the customary agitating and pumping equipment and skid steer/loader. Any additional items found in the manure storage (concrete block, tires, garbage, etc.) must be removed before abandonment begins and not spread on fields.

NOTE: The existing manure storage ponds shall be surveyed/measured by the engineer after all the manure has been removed, and prior to any contaminated soils being removed from the site.

Existing HDPE Pond Liner

The existing HDPE pond liner and cover will be removed and disposed of in a landfill.

Remove Contaminated Soil *(Shall Be Observed By Engineer/Technician)*

Manure contaminated soil shall be removed. The contaminated soil may be pushed with a bull dozer or scraper, and/or placed into a dump truck or manure spreader for transportation to the spreading site. A minimum of 6" of soil must be removed from the manure storage structure including from under the concrete floor area, with an additional 6"-24" of soil requiring removal if additional soil is contaminated with manure. The final amounts and depths of soil needing to be removed from the structure will be determined by the engineer on site. The manure storage structure must be completely free of contaminated soils and manure prior to beginning construction of the proposed manure storage structures.

Contaminated soils shall be transported to the spreading site where the soil will be spread out over the site at a depth not to exceed 12 inches. Soils at the spreading site shall not be intentionally compacted. It may be desirable to spread the soil into a layer only a few inches thick and then to incorporate the spread material into the existing soils using a disk or plow. A cover crop or permanent crop may be planted over the spreading site. A cover crop would stabilize the site until such time that an agricultural crop may be planted to help remove nutrients from the spread soil.

Existing Waste Transfer Pipe

There are two existing waste transfer pipes that currently discharge into the waste storage facility. The outlet end of the transfer pipes shall either be removed or encased in concrete to terminate use.

Final Grading Of Site

The completely abandoned waste storage facility site will graded to the south and will be seeded and mulched. Long-term use of the abandoned site is unknown at this time.

Additional Abandonment Details

1.) The final grade of the abandoned HDPE Lined Waste Storage Facility area is approximately 2.5% to the south.

2.) It unknown how much contaminated material will need to be removed until the abandonment process begins.

Benchmark Locations

Emerald Sky Dairy, LLC

TBM #1 El 1211.23 Point #6003

TBM #2 El 1220.20 Point #6004

TBM #3 El 1220.24 Point #6006

TBM #50 El 1224.85 Point #6009

TBM #51 El 1193.91 Point #6010

TBM #52 El 1192.60 Point #6586

TBM #53 El 1213.18 Point #6712

Endangered Resources Preliminary Assessment

Created on **8/11/2017**. This report is good for one year after the created date.

Results

No actions required/recommended. No endangered resources have been recorded in this area. For additional information on Endangered Resources (ER) Reviews, please visit: http://dnr.wi.gov/topic/ERReview/Review.html

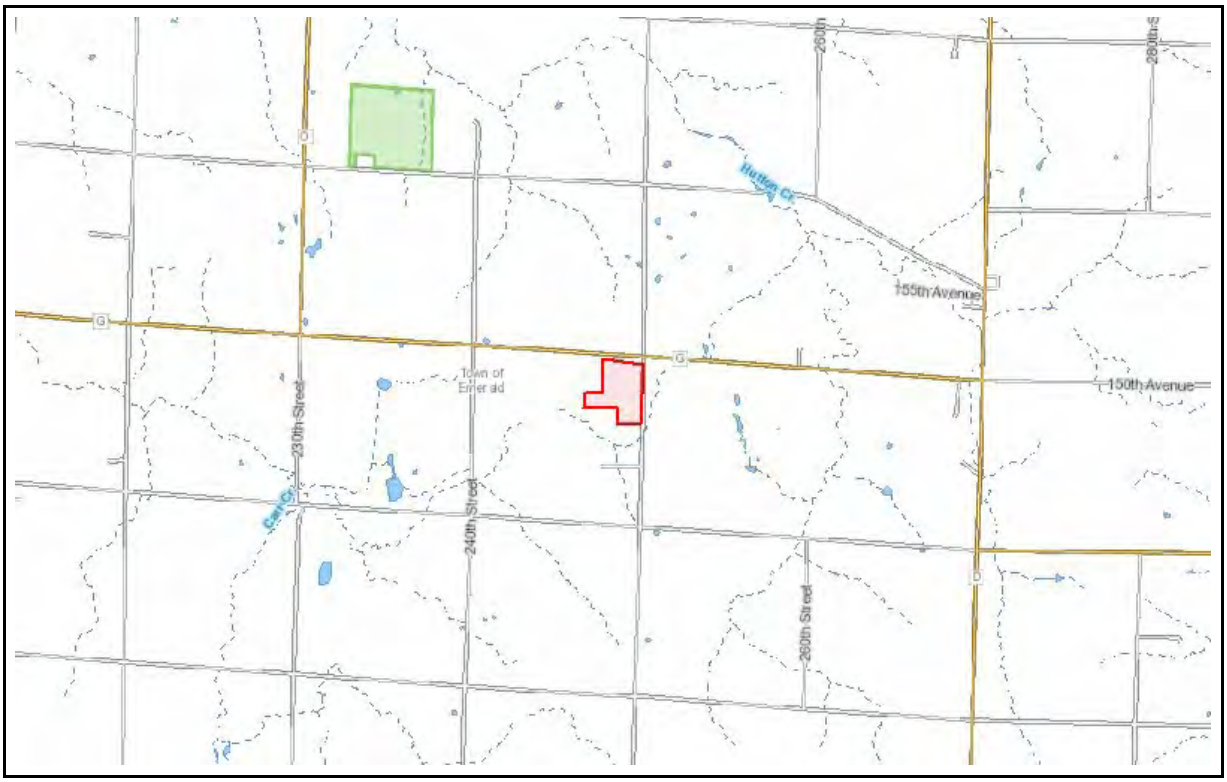
Project Information

Landowner name	Todd Tuls
Project address	Emerald, WI
Project description	Farm Improvements

Project Questions

Does the project involve a public property?	No
Is there any federal involvement with the project?	No
Is the project a utility, agricultural, forestry or bulk sampling (associated with mining) project?	Yes
Is the project property in Managed Forest Law or Managed Forest Tax Law?	No

Project Area Maps



The information shown on these maps has been obtained from various sources, and is of varying age, reliability and resolution. These maps are not intended to be used for navigation, nor are these maps an authoritative source of information about legal land ownership or public access. Users of these maps should confirm the ownership of land through other means in order to avoid trespassing. No warranty, expressed or implied, is made regarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map. For more information, see the DNR Legal Notices web page: http://dnr.wi.gov/legal/.

Operation And Maintenance Plan

Emerald Sky Dairy, LLC
TOWN OF Emerald
St. Croix County, WISCONSIN

Prepared by:

Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
715-829-3231

August, 2017

Table of Contents

Introduction

Williams Engineering Services, INC (WES) has developed this Operation and Maintenance (O&M) Plan as a guide for proper management for the Emerald Sky Dairy, LLC facility in the Town of Emerald of St. Croix County, Wisconsin.

For the Emerald Sky Dairy facility to function properly after construction, proper operational procedures and upkeep must be performed. This Operation and Maintenance Plan provides the operator with appropriate information to recognize problems at the dairy facility.

This document does not include the day-to-day operational schedule nor does it contain the specific information for each piece of equipment, etc.

The landowner should utilize this Operation and Maintenance Plan in its entirety. Inspection forms were created to assist the operator in thoroughly inspecting the various systems.

The components listed below are the areas that require special attention. It should be known that this not a complete list. A thorough inspection of the entire facility should be completed as well. At a minimum, the following systems of the proposed Emerald Sky Dairy facility will require inspection:

- Existing HDPE Lined and Covered Waste Storage Facility (WSF #1)
- Concrete Lined Waste Storage Facility (WSF #2)
- Three HDPE Lined and Covered Waste Storage Facilities (WSF #3-4)
- Waste Transfer System
    - TMF Collection Tank to WSF #1
    - Heifer Lot Collection Tank to WSF #1
    - Feed Pad Collection Tank to WSF #1
    - Solid Separator Collection Tank to WSF #1
- Feed Pad and Feed Pad Transfer System
- Waterways and Infiltration Basin and Emergency Secondary Containment Basin
- Concrete Stacking Areas
- Heavy Use Protection Areas and Access Roads
- Fences and Gates

To achieve the intended function and sustain the 1 year design storage capacity of the combined concrete and HDPE lined waste storage facilities, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

- Evaluate the remaining storage capacity of WSF #2. Stage Storage Pins located on the safety wall will indicate the remaining volume, Maximum Operating Level (MOL), one foot freeboard and the overflow point. Land apply or transfer to another WSF if storage remaining is approaching MOL.
- Inspect the concrete components for signs of cracking. All cracks larger than 1/8 inch shall be cleaned and sealed by high pressure washing to remove any material in the cracks, then acid etch the cracks using muriatic acid followed by an additional power washing, and then the cracks shall be thoroughly dried and then sealed with hydrophilic sealant and/or expanding grout. Defects larger than ¼ inch shall be brought to the attention of the design engineer and reported to the WDNR and St. Croix County LCD and repaired per emergency repair plan prepared by the design engineer and approved by the required agencies.
- Examine the basin and inlet pipe for seepage, cracks or separation after empting of the WSF. Repair any defects immediately.
- Examine embankments for seepage, erosion and animal activity. Remove any burrowing animals. Repair embankment and reseed.
- Maintain necessary safety features including fences, gates, proper safety signs, stop blocks and covers.
- Mow embankments and maintain erosion preventive vegetation. Reseed any areas that are lacking vegetation.

General guidelines and Safety Precautions:

- Follow Nutrient Management Plan
- Do not dispose human waste, animal mortality or other wastes in WSF.
- Follow all Wisconsin Occupational Health and Safety regulations.
- Minimize odor air drift when possible.

The proposed waste storage facility is designed in accordance with the WI NRCS 313 – *Waste Storage Facilities.*

To achieve the intended function and sustain the 1 year design storage capacity of the combined HDPE and concrete lined waste storage facilities, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

Evaluate the remaining storage capacity of Existing WSF #1 & WSF #2. Stage Storage Pins located in the pump-out tank will indicate the remaining volume, Maximum Operating Level (MOL), one foot freeboard and the overflow point. Land apply or transfer to another WSF if storage remaining is approaching MOL.

- Examine the inlet pipe for seepage, cracks or separation after empting of the WSF. Repair immediately.
- Check for punctures, defects or wildlife damage in the HDPE liner. If defects or damage is found, contact the HDPE installation company to schedule the repair.
- Examine embankments for seepage, erosion and animal activity. Remove any burrowing animals. Repair embankment and reseed.
- Inspect HDPE vents for blockages. Remove and clean if any found.
- Check HDPE cover for damages. If found, repair according to repair manual by the manufacturing company.
- Maintain necessary safety features including fences, gates, proper safety signs, stop blocks and covers.
- Mow embankments and maintain erosion preventive vegetation. Reseed any areas that are lacking vegetation.

General guidelines and Safety Precautions:

- Follow Nutrient Management Plan
- Do not dispose human waste, animal mortality or other wastes in WSF.
- Follow all Wisconsin Occupational Health and Safety regulations.
- Minimize odor air drift when possible.

The proposed waste storage facilities are designed in accordance with the WI NRCS 313 – *Waste Storage Facilities.*

To achieve the intended function and sustain the functionality of the waste transfer system, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

Inspect the concrete components for signs of cracking. All cracks larger than 1/8 inch shall be cleaned and sealed by high pressure washing to remove any material in the cracks, then acid etch the cracks using muriatic acid followed by an additional power washing, and then the cracks shall be thoroughly dried and then sealed with hydrophilic sealant and/or expanding grout. Defects larger than ¼ inch shall be brought to the attention of the design engineer and reported to the WDNR and St. Croix County LCD and repaired per emergency repair plan prepared by the design engineer and approved by the required agencies.

- Inspect the pumps for functionality and for debris blockage.
- Check for chucks or debris that could potentially block flume openings.
- Evaluate all electrical and mechanic equipment to insure they are properly functioning in accordance to manufacture's standards.
- Maintain adequate cover for buried pipes to prevent freezing.
- All safety guards, shields, grates, lids and warning signs must be maintained.

General guidelines and Safety Precautions:

- Limit driving of machinery to designated areas that are designed to withstand equipment weight.
- Follow all Wisconsin Occupational Health and Safety regulations.
- Do not allow humans to enter the any enclosed areas without proper safety equipment.
- Avoid digging near pipes that could result in damage.

The proposed waste transfer system is designed in accordance with the WI NRCS 313 – *Waste Storage Facilities,* WI NRCS 634 – *Waste Transfer System,* WI NRCS 533 – *Pumping Plant,* WI NRCS 430– *High Pressure, Underground, Plastic Pipe.*

Feed Pad Area

To achieve the intended function and sustain the functionality of the feed pad area, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

Inspect the concrete components for signs of cracking. All cracks larger than 1/8 inch shall be cleaned and sealed by high pressure washing to remove any material in the cracks, then acid etch the cracks using muriatic acid followed by an additional power washing, and then the cracks shall be thoroughly dried and then sealed with hydrophilic sealant and/or expanding grout. Defects larger than ¼ inch shall be brought to the attention of the design engineer and reported to the WDNR and St. Croix County LCD and repaired per emergency repair plan prepared by the design engineer and approved by the required agencies.

- Avoid using equipment that may damage the surface.
- Check for animals that may be burrowing beneath the concrete slab. Remove any burrowing animals. Replace removed fill and reseed.

General guidelines and Safety Precautions:

- Follow all Wisconsin Occupational Health and Safety regulations.
- Do not dispose human waste, animal mortality or other wastes on stacking areas.

The proposed feed pad area is designed in accordance with the WI NRCS 629 – *Waste Treatment.*

Infiltration Basins and Waterways

To achieve the intended function and sustain the functionality of the infiltration basin and waterways, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

Maintain the designed elevations of the waterway and infiltration basin. If the elevation is scoured or lower due to erosion, replace fill and reseed.

- Any rock riprap that is displaced by water should be moved back to original locations.
- Prevent soil and other solid material from entering waterways and being transported to the infiltration basin where solids may impede infiltration.
- Check for animals that may be burrowing into the structures. Remove any burrowing animals. Replace removed fill and reseed.
- Check for debris that may block or impede water flow to infiltration basin.
- Maintain erosion preventive vegetation. Reseed any areas that are lacking vegetation.

General Guidelines and Safety Precautions:

- Limit traffic over culverts and on grassed waterways to prevent damage.
- Monitor sediment buildup. If sediment buildup has reduced infiltration, remove and spread to field depressions and reseed.

The proposed infiltration basins and waterway are designed in accordance with the WI NRCS 342 – *Critical Area Plantings,* WI NRCS 412 – *Grassed Waterway,* WI NRCS 587 – *Structure for Water Control.*

Concrete Stacking Areas

To achieve the intended function and sustain the functionality of the concrete stacking area, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

Inspect the concrete components for signs of cracking. All cracks larger than 1/8 inch shall be cleaned and sealed by high pressure washing to remove any material in the cracks, then acid etch the cracks using muriatic acid followed by an additional power washing, and then the cracks shall be thoroughly dried and then sealed with hydrophilic sealant and/or expanding grout. Defects larger than ¼ inch shall be brought to the attention of the design engineer and reported to the WDNR and St. Croix County LCD and repaired per emergency repair plan prepared by the design engineer and approved by the required agencies.

- Only equipment with weights equal or less than the concrete flatwork design criteria should be allowed on paved stacking areas.
- Evaluate the remaining storage in the stacking areas. Land apply, or transfer to another stacking area if insufficient volume remains.
- Examine embankments for seepage, erosion and animal activity. Remove any burrowing animals. Replace embankment fill and reseed.
- Maintain necessary safety features including proper safety signs and other safety features,
- Mow embankments to maintain erosion preventive vegetation. Reseed any areas that are lacking vegetation.

General guidelines and Safety Precautions:

- Follow Nutrient Management Plan
- Do not dispose human waste, animal mortality or other wastes on stacking areas.
- Follow all Wisconsin Occupational Health and Safety regulations.
- Minimize odor air drift when possible.

The proposed concrete stacking area is designed in accordance with the WI NRCS 313 – *Waste Storage Facilities,* WI NRCS 634 – *Waste Transfer System.*

Heavy Use Protection Areas and Access Roads

To achieve the intended function and longevity of the heavy use protection areas and access roads, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

Maintain the surfaces of the areas. For gravel roads, add material and grade when depressions form. For concrete and asphalt, inspect for cracking and areas of damage.

- Check for animal activity near roads and culverts. Remove any burrowing animals. Replace removed fill and reseed.
- Avoid equipment that may damage the surface.

The proposed heavy use protection areas and access roads are designed in accordance with the WI NRCS 342 – *Critical Area Plantings,* WI NRCS 412 – *Grassed Waterway,* WI NRCS 587 – *Structure for Water Control.*

Fences and Gates

To achieve the intended protection of health and safety, this Operation and Maintenance Plan must be followed. In order maintain functionality, the landowner must perform diligent inspections, perform preventive maintenance and implement corrective actions to any problems that may arise. The following plan is to act as a guide:

All Gates/Openings shall remain closed at all times unless authorized personnel are available to assist.

- Inspect fence post for their durability. Any posts that are broken or pushed over should be replaced.
- Fencing should be sufficiently rigid to withstand pressure without collapsing. Any fencing that is sagging should be retightened or replaced if damaged.
- Inspect fasteners. Any damaged or loose fasteners should be replaced.
- Maintain fence visibility at all times. Grass and weeds should be clipped when impeding visibility.
- Safety signs should be placed at 200 feet maximum intervals.

General Guidelines and Safety Precautions:

- All gates must be locked or fastened close to avoid damage and unauthorized access.
- For HDPE WSF, do not mow or trim weeds within one foot of structure. Mowers and trimmers will cut the HDPE liner.

Plan in the Event of A Spill:

This contingency plan pertains to the spill of solid and liquid waste as well as contaminated runoff. Enact this plan if a spill occurs. Emergency contact information is available in the Emergency Response Plan.

1. Manure spill on farmstead:
    - Stop the source of the leak or spill. Turn off all pumps/valves and clamp hoses or park tractor on hoses to stop flow.
    - Contain the spill by means of grading a shallow ridge to prevent entry to the downstream waterway. A tractor mounted back blade is available for this purpose.
    - Use pumps to recover and directly land apply on approved sites.
2. Manure spill on public road and/o right-of-way:
    - Stop the source of the leak or spill. Turn off all pumps/valves and clamp hoses.
    - Inform Wisconsin Hazardous Spill Line at 1-800-943-0003. Spill reporting is mandatory by state law.
    - Inform the local sheriff's, police, and/or Department of Transportation for traffic control.
    - Contain the spill in the road ditch before it can enter a stream or body of water by blocking downslope culverts and building dikes/ditches to divert or contain with a skid loader or a tractor mounted back blade.
    - Remove manure from the roadway and roadside with a skid loader or a tractor mounted back blade.
    - Use pumps to recover liquids and/or directly land apply on approved sites.
    - Document your actions.
3. When the maximum operating level is reached on any manure storage structure, manure shall be field applied or transferred to another storage location on the farm.
4. Be prepared to provide the following information:
    - Your name and contact information.
    - Farm address, location, and/or other pertinent identification information.
    - Nature of emergency (employee injury, fire, discharge of manure or hazardous materials, etc.)
    - Potential for manure or hazardous materials to reach surface waters or major field drains.
    - Current status of containment efforts.
    - Location(s) of hazardous/flammable materials and fire suppression equipment.

Plan if Waste Reaches Maximum Operating Level:

If liquid level reaches the maximum operating level the landowner/operator will pump material from the structure to maintain an operating level below the maximum. The operator may land apply or transfer to another WSF that is below the MOL.

Attachment 1

Inspection Logs

Emergency Response Plan

Emergency Incident Report

Transfer Failure Analysis

Inspection Logs
Emerald Sky Dairy, LLC
St. Croix County, Wisconsin

System	Inspection Description	Maintenance		Notes/Observations
		Yes	No	
Concrete WSF #1	Evaluate remaining storage			
	Inspect for concrete cracks			
	Examine pipe for damage			
	Inspect saftey features			
	Check for seepage			
	Check for animal activity			
	Evaluate embankment for erosion			
HDPE WSF #2	Evaluate remaining storage			
	Inspect for punctures in liner			
	Examine pipe for damage			
	Inspect saftey features			
	Check for seepage			
	Check for animal activity			
	Evaluate embankment for erosion			
	Inspect HDPE cover for damages			
	Examine vents for blockages			
Waste Transfer	Inspect pumps			
	Inspect for concrete cracks			
	Examine pipe for damage			
	Inspect saftey features			
	Check for pipe blockages			
	Inspect pipe cover			
	Evaluate electric equipment			
Feed Pad Area	Check for animal activity			
	Inspect for concrete cracks			
Leachate Collection Tank	Inspect pumps			
	Inspect for concrete cracks			
	Examine pipe for damage			
	Inspect saftey features			
	Check for debris chucks			
	Check for animal activity			
	Evaluate electrical equipment			
	Maintain cover over pipes			

Inspector: Date:

Inspection Logs
Emerald Sky Dairy, LLC
St. Croix County, Wisconsin

System	Inspection Description	Maintenance		Notes/Observations
		Yes	No	
Infiltration Basin and Waterways	Evaluate erosion			
	Inspect rock riprap placement			
	Check for animal activity			
	Inspect vegatation			
Concrete Stacking Areas	Inspect for concrete cracks			
	Evaluate remaining storage			
	Check for animal activity			
	Inspect saftey features			
	Insure equipment is under weight			
Heavy Use Area & Access Roads	Inspect for surface weathering			
	Evaluate surface levelness			
	Check for animal activity			
	Inspect saftey features			
	Insure equipment is under weight			
Fence and Gates	Inspect fence posts			
	Evaluate fence rigidness			
	Check fasteners			
	Maintain fence visibility			
	Insure safety signs are in place			

Inspector: Date:

Emergency Response Plan

Farm Name: Emerald Sky Dairy, LLC

Owner/Operator: Emerald Sky Dairy, LLC Phone: 402-996-0848 Cell: _____

Owner/Operator: TJ Tuls Phone: 402-526-2385 Cell: 402-366-0363

Farm Address: 2487 County Road G, Emerald, WI 54013

Farm Location: T 30 N, R 16 ◉E ○W Section 22 County: St. Croix

Driving Directions or Emergency Coordinates: Take Hwy 63 North From Baldwin, WI, Turn Right Onto County Road O, Emerald Sky Will Be On the Right After 240th Street and Before 250th Street

In Case of Injury, Fire, or Rescue Emergency, Immediately Implement the Following:

1. Assess the condition of the victim, extent of the emergency (fire, rescue) and call for help.
2. Stabilize the victim, use on-site rescue equipment, evacuate buildings, or begin fire suppression as necessary.
3. Brief emergency responders upon arrival on current status of situation.

In Case of a Spill, Leak, or Failure at the Storage Facility, During Transport, or Land Application, Immediately Implement the Following:

1. Stop the source of the leak or spill. For example:
   - Turn off all pumps/valves and clamp hoses or park tractor on hoses to stop the flow of manure.
2. Assess the situation and make appropriate calls for people, equipment, and materials. See contacts below.
   - Notify DNR spill hotline: 1-800-943-0003 (Spill reporting is mandatory by state law.)
   - Call sheriff's office if spilled on public roads or its right-of-ways for traffic control.
   - Clear the road and roadside of spilled material immediately.
3. Contain the spill and prevent spillage from entering surface waters, tile intakes, or waterways.
   - Use a skid loader or tractor with a blade to build dikes to contain or divert the spill or leak.
   - Insert sleeves around tile intakes (or plug/cap intakes) and block down slope culverts.
   - Use tillage implements to work up the ground ahead of the spill or use absorptive materials.
4. Begin cleanup.
   - Use pumps to recover liquids.
   - Land apply on approved cropland at appropriate rates.
5. Document your actions.

Emergency Contacts	Contact Person (or Company)	Phone Number
Fire/Rescue	Glenwood Fire Department	911 or 715-265-7883
County Sheriff	St. Croix County Sheriff	911 or 715-381-4339
Farm Emergency Coordinator	Todd Tuls/TJ Tuls	402-366-0363/402-996-0848
DNR Hazardous Spill Line		1-800-943-0003
DNR Permit Contact/Warden	Robert Rohland	715-284-1429
Veterinarian	TBD	
Equipment/Supplies	**Contact Person (or Company)**	**Phone Number**
On-Farm Equipment Operator	TBD	
Excavation Contractor	TBD	
Manure Hauler	TBD	
Septic Tank Pumping Truck	TBD	
Mortality Disposal Contractor	TBD	
Local Government Contacts	**Contact Person**	**Phone Number**
Town Chairman	Henry Hurtgen	715-977-0008
LCD County Conservationist	Steve Olson	715-531-1908
NRCS District Conservationist	Jason Barrick	715-684-2874

Be prepared to provide the following information:

- Your name and contact information
- Farm address, location and other pertinent identification information.
- Nature of emergency (employee injury, fire, discharge of manure or hazardous materials).
- Emergency equipment and personnel that are needed.
- Potential for manure or hazardous materials to reach surface waters or major field drains.
- Current status of containment efforts.
- Location of hazardous/flammable materials, fire suppression equipment, emergency cut off switches or valves.

Emergency Action Plan - Incident Report

Date and Time of Incident: (MM/DD/YYYY), 00:00.00 AM/PM)

Location of Incident:

Parties Involved in Incident: (First & Last Name, Company/Agency)

Description of Incident:

Incident Resolution:

Worksheet Completed By: _____ _____

Name (Print) Signature

Date Completed: _____

Transfer Pipe Failure Analysis

The transfer pipe failure analysis is provided to evaluate hypothetical transfer pipe failure scenarios. The purpose of the transfer pipe analysis is to provide information on how to prevent a failure or to resolve any possible failure that may arise throughout typical operation of the transfer pipe(s). Certain failures that cannot be prevented shall be documented in the operation and maintenance plan as well as actions that may be taken to resolve a problem. See also the emergency action plan for additional information.

1. Transfer Pipe Blockage
    a. Design Solutions
        i. Where feasible, transfer pipes shall have clean-out access spaced at every 150' maximum spacing for single risers and 300' maximum spacing for bi-directional risers to allow for removal of settled solids or obstructions. (*In accordance with WI NRCS 634 – Waste Transfer Pipe*)
        ii. Flume Supply and waste discharge pipes are sloped back to the reception structure to allow discharge from flushing operations of the pipe(s) to drain back to the reception structure.
        iii. A valve shall be placed on the transfer pipe at the location of the waste storage facility the pipe is discharging into to allow use of the cleanouts when liquid levels in the basin are at or above the pipe elevation.
    b. Operations & Maintenance Solutions
        i. Empty storage structure as necessary to allow back flow from discharge and supply pipes and to allow safe access to the pipe.
        ii. Close in-line valves as necessary to prevent backflow while any pipe maintenance is being performed.
        iii. Remove clean-out covers to allow jetting and/or vacuuming of transfer lines.
    c. Emergency Response Plan Solutions
        i. Contain any waste. If waste or contaminants enter the secondary containment, close the secondary containment outlet culvert valves to contain the waste and prevent it from leaving the site.
        ii. Report spill to appropriate authorities and clean up the spill immediately.
2. Transfer Pipe Breakage
    a. Design Solutions
        i. The transfer pipe system is designed with the appropriate pipe material and sizing to accommodate the intended purpose of the transfer system.
        ii. The current design has redundant pumps and pipelines installed in case of a main transfer pipe system failure.
    b. Operations & Maintenance Solutions
        i. Discontinue the use of system components that have malfunction or failed and replace as necessary under the direction of the design engineer to allow the transfer system to operate as designed.
        ii. If a failure occurs, implement any backup system available to use temporarily until the main system components can be repaired or replaced.
        iii. Evaluate the cause of the system failure and determine necessary means of fixing the system or replacing the system.
    c. Emergency Response Plan Solutions
        i. Contain any waste. If waste or contaminants enter the secondary containment, close the secondary containment outlet culvert valves to contain the waste and prevent it from leaving the site.

ii. Report spill to appropriate authorities and clean up the spill immediately.

3. Cross Channel Blockage (Flush Flume)
    a. Design Solutions
        i. A removable steel grate is placed atop scrape alley drops to allow access to clean any blockage of the drops and allow access into the drops.
        ii. A flume supply re-circulation system is installed to flush the system and aid in the cleaning of the channel.
    b. Operations & Maintenance Solutions
        i. The system intent is for the waste manure to be scraped from the manure alleys directly into the concrete drops or waste must be manually hauled if the channel is offline.
        ii. Flush the transfer pipe with recirculated water from the reception pit continually to reduce solid buildup that may result in blockage.
    c. Emergency Response Plan Solutions
        i. Contain any waste. If waste or contaminants enter the secondary containment, close the secondary containment outlet culvert valves to contain the waste and prevent it from leaving the site.
        ii. Complete the Incident Form and report spill to appropriate authorities and clean up the spill immediately.
4. Plugging of Crossover Pipe Between Storage Facilities
    a. Design Solutions
        i. A combination of two pipes at different elevations are to be installed at three separate locations from storage structure to storage structure.
        ii. Knife valves are to be placed on each pipe to control the flow of waste from one storage structure to the next.
    b. Operations & Maintenance Solutions
        i. Cross over valves must remain closed at all times unless any one particular crossover pipe is in use (per pond.)
        ii. Periodically operate the valves to reduce the risk of cease up of valves.
        iii. If a crossover pipe is to plug or fail, utilize one of the remaining two crossovers until the waste level is a safe level to repair or replace the failed pipe or valve.
        iv. In the case of all crossover pipes failing, manually pump the waste between storage facilities.
        v. Desirable to use one crossover at any one time to maximize flow rate.
    c. Emergency Response Plan Solutions
        i. Contain any waste. If waste or contaminants enter the secondary containment, close the secondary containment outlet culvert valves to contain the waste and prevent it from leaving the site.
        ii. Report spill to appropriate authorities and clean up the spill immediately.
        iii. See Emergency Response Plan and Complete the Incident Report Form

Chapter ATCP 51
Appendix A

EMERALD SKY DAIRY, LLC
TOWN OF EMERALD
ST. CROIX COUNTY, WISCONSIN

Prepared by:
Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
715-829-3231

August, 2017

Chapter ATCP 51

APPENDIX A

APPLICATION FORM AND WORKSHEETS

Application for Local Approval
New or Expanded Livestock Facility

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive
P.O. Box 8911
Madison, WI 53708−8911
(608) 224−4622
(608) 224−4500

Introduction

Use this application form to obtain local approval for a *new* or *expanded* livestock facility (cattle, swine, poultry, sheep or goats) that will exceed 500 “animal units” (or a lower threshold established by local zoning ordinance prior to July 19, 2003).

Some local governments require local approval, but others do not. Check with your local government (county and town or municipality) to see if local approval is required in your area.

In some cases, you may need local approval from more than one local government (for example, the county and the town, or 2 towns if your livestock facility straddles the town line). But the application and approval process should be the same.

The construction of a new or altered *livestock structure* does not, by itself, constitute an “expansion” (unless there will also be an increase in *animal units*). If you already have a permit or local approval, you may not need another approval unless your planned expansion exceeds the number of animals previously authorized by your local government.

Local approval, if required, is governed by statewide uniform standards in Wisconsin Statutes s. 93.90 and Wisconsin Administrative Code chapter *ATCP 51*. This application documents compliance with those standards.

The Livestock Facility

A livestock facility includes livestock, livestock structures, the land on which they are located (it does not include pastures or winter grazing areas). *Related livestock facilities* (see definition below) are treated as a single livestock facility, for purposes of local approval. However:

- *A separate species facility* (see definition below) may be treated as a separate livestock facility, even if it is owned by the same person and located on the same land parcel as another livestock facility.
- A mere acquisition of a neighboring livestock facility does not constitute an *expansion* unless more *animal units* are added to the combined facilities.

Completing the Application

If local approval is required, complete this entire application form (including the worksheets). Follow the instructions in the application form. Attach all of the supplementary documentation required. Your application must be complete, credible and internally consistent.

The application form and worksheets ask for information to show compliance with Wisconsin livestock facility siting standards. A local government has *very limited* authority to modify the standards by local ordinance (modifications, if any, must be reflected in the local version of this application form).

As part of your application, you must specify the number of *animal units* that you will keep at a new or expanded livestock facility. If the local government approves your requested number, this will be the maximum number that you may keep for 90 days or more in any 12−month period.

A local government may require you to submit up to 4 duplicate copies of the complete application, worksheets, maps and other attachments. But you are not required to submit duplicate copies of engineering design specifications.

Worksheets

This application includes the following worksheets:

- *Animal units* (worksheet 1)
- Odor management (worksheet 2)
- Waste and nutrient management (worksheet 3)
- Waste storage facilities (worksheet 4)
- Runoff management (worksheet 5)

Complete the worksheets following all instructions (including those on each worksheet). You may use a convenient automated spreadsheet in place of Tables A and B of worksheet 2 if you prefer (results are identical). The spreadsheet is available at http://www.datcp.state.wi.us.

If the Wisconsin Department of Natural Resources (*DNR*) has issued a Wisconsin Pollutant Discharge Elimination System (*WPDES*) permit for your proposed livestock facility, you can check a box on worksheets 3, 4 and 5, and submit a copy of that permit with the worksheets. A *WPDES* permit does not affect the requirements for completing worksheets 1 and 2.

Fees

A local government may require a fee to offset its reasonable costs to review and process this application. The fee, if any, must be established by local ordinance and may not exceed $1,000. A local government may NOT charge any other fee, or require you to post any bond or security.

Local Approval Process

If you complete the application properly, the local government MUST APPROVE the proposed livestock facility unless it finds, based on clear and convincing evidence in the local record, that the facility fails to meet the state standards.

Within 45 days after you submit your application, the local government must notify you whether your application is complete. If you failed to complete part of the application, you must submit the missing information. The local government must grant or deny the application within 90 days after it declares the application complete, and issue its decision in writing. The approval must include a duplicate copy of the approved application, marked "approved." The duplicate copy shall include all the worksheets, maps, and other attachments included in the application, with the exception of the engineering design specifications. The local government must make a record of its decision making process, and the evidence supporting its decision. The record must include your application.

Appeal of Local Decision

If you disagree with the local government's decision on your application, you may appeal that decision to the Wisconsin Livestock Facility Siting Review Board ("Board"). Other "aggrieved persons" may also appeal to the Board. An "aggrieved person" includes any person who resides or owns land within 2 miles of your proposed livestock facility.

You must file your appeal within 30 days after the local government issues its decision (or, if you pursue a local administrative appeal process first, within 30 days after that appeal process is complete). The Board will review the local decision based on the evidence in the local record (it will not hold a new hearing or accept new testimony or evidence). You must file your appeal in writing at the following address:

Wisconsin Livestock Facility Siting Review Board
c/o Secretary, Department of Agriculture, Trade and Consumer Protection
P.O. Box 8911
Madison, WI 53708−8911

Terms Used in this Application Form

In this application form, you will see a number of ***italicized*** terms. Those terms are defined below (for more specific definitions, see *ATCP 51*):

"Adjacent" – Located on land parcels that touch each other, or on land parcels that are separated only by a river, stream, or transportation or utility right−of−way.

"Affected Neighbors" – Residences or *high−use buildings* within 2500 feet of any livestock structure at the proposed facility, other than those owned by the applicant or by persons who have agreed to exclude them from the applicant's odor score calculation. The total odor score for a *livestock facility* depends, in part, on the proximity and density of "affected neighbors."

"Animal housing area" – That portion of an animal housing structure to which animals have access, and in which manure may accumulate. "Animal housing area" includes free−stalls and travel lanes. It does NOT include holding areas, feed alleys, storage areas or milking parlors.

"Animal lot" − A feedlot, barnyard or other outdoor facility where livestock are concentrated for feeding or other purposes. Pastures and winter grazing areas are NOT "animal lots." Treat multiple "animal lots" as a single "animal lot" if runoff from the "animal lots" drains to the same treatment area or if runoff from the "animal lot" treatment areas converges or reaches the same surface water within 200 feet of any of those treatment areas.

"Animal units" – Equivalent units of *livestock*. The number of animals constituting an "animal unit" varies by species. For example, one milking dairy cow equals 1.4 "animal units." A beef animal over 600 lbs. equals 1.0 "animal units." A pig over 55 lbs. equals 0.4 "animal units." A laying chicken equals 0.01 "animal unit." The number of "animal units" kept at a *livestock facility* means the largest number of "animal units" that will be at the *livestock facility* on at least 90 days in any 12−month period. Calculate "animal units" according to worksheet 1.

"BARNY runoff model" – The Wisconsin version of a model that is commonly used to predict nutrient runoff from *animal lots*. An Excel computer spreadsheet version is available on the DATCP website (engineering directory).

"Certified agricultural engineering practitioner" – A practitioner who is properly qualified under *ATCP 50.46*.

"Cluster" – Any group of one or more *livestock structures* within a *livestock facility*. If you wish to do so, you may calculate separate odor scores for "clusters" that are separated by more than 750 feet.

"Complete application for local approval" – An application that contains everything required under ss. ATCP 51.30(1) to (4).

"DATCP" – Wisconsin Department of Agriculture, Trade and Consumer Protection. The application form cites DATCP rules including Wis. Adm. Code chs. *ATCP 51* (livestock facility siting), *ATCP 50* (soil and water resource management) and *ATCP 17* (livestock premises registration).

"DNR" – Wisconsin Department of Natural Resources. The application form cites DNR rules including Wis. Adm. Code chs. *NR 243* (*WPDES* permits), *NR 811* (community wells) and *NR 812* (private wells).

"Expanded livestock facility" − The entire *livestock facility* created by an *expansion*, including new, existing and altered *livestock structures* (existing structures are subject to less rigorous standards). Your application must indicate the maximum number of *animal units* that you will keep at the "expanded livestock facility."

"Expansion" – An increase in the largest number of *animal units* kept at a *livestock facility* on at least 90 days in any 12−month period. The acquisition of an existing livestock facility, by the operator of an *adjacent* facility, is not an "expansion" unless the operator increases the largest number of *animal units* kept at the combined livestock facilities on at least 90 days in any 12−month period.

"High−use building" – A residential building that has at least 6 distinct dwelling units; a restaurant, hotel, motel, or tourist rooming house; a school building; a hospital or licensed care facility; or a non−farm business or workplace that is open at least 40 hours a week. The odor score for your *livestock facility* depends, in part, on the proximity and density of neighboring "high−use buildings."

"Karst features" – Sinkholes, fractured bedrock or like features that may result in direct pollution runoff to groundwater.

"Livestock" – Cattle, swine, poultry, sheep or goats.

"Livestock facility" – A feedlot, dairy farm, or other operation where *livestock* are or will be fed, confined, maintained, or stabled for a total of 45 days or more in any 12−month period. A "livestock facility" includes all of the tax parcels on which the facility is located, but it does NOT include a parcel used only for *pasture* or as a *winter grazing area*. *Related livestock facilities* are considered a single "livestock facility," except a livestock operator may elect to treat a *separate species facilities* as a separate livestock facility.

"Livestock structure" – A building or structure such as a barn, milking parlor, feed storage facility, feeding facility, *animal lot* or *waste storage structure*. *Pastures*, *winter grazing areas* and machine sheds are NOT "livestock structures."

"Local approval" – A license, permit, special zoning exception, conditional use permit, or other local authorization for a *new or expanded livestock facility*. This application form applies, regardless of the form of local approval. However, this application form does NOT cover any of the following permits (for which separate requirements may apply):

- Building, electrical or plumbing permits (if local standards are consistent with state code).
- Manure storage system permits (*see ATCP 50.56*), UNLESS construction is part of a *new or expanded livestock facility*.
- Permits required by certain local ordinances related to shoreland zoning, floodplain zoning, construction site erosion control or stormwater management.

"New livestock facility" – A *livestock facility* used for the first time, or for the first time in at least 5 years.

"NRCS" – The Natural Resource Conservation Service of the United States Department of Agriculture. Wisconsin livestock siting standards refer to NRCS Technical Guide standards.

"Pasture" – Land on which livestock graze or otherwise seek feed in a manner that maintains the vegetative cover over all of the grazing or feeding area.

"Premises ID" – The unique ID number assigned to your *livestock facility* under the Wisconsin Livestock Premises Registration Program (*ATCP 17*). Go to http://www.datcp.state.wi.us for more information. To register your *livestock facility*, go to http://www.wiid.org/.

"Qualified nutrient management planner" − A person, other than the applicant, who is qualified under *ATCP 50.48.*

"Related livestock facilities" – Two or more *livestock facilities* that are owned or managed by the same person and meet any of the following criteria:

- They are located on the same tax parcel or *adjacent* tax parcels.
- They use any of the same *livestock structures* to collect or store manure.
- They generate manure that is applied to the same parcel of land.

"Separate Species Facility" − A distinct part of *a livestock facility* that meets all of the following criteria:

- It has only one of the following types of livestock, and that type is not found in any other part of the *livestock facility*:
  - Cattle
  - Swine
  - Poultry
  - Sheep
  - Goats
- It has no more than 500 *animal units*.
- Its animal housing and manure storage structures, if any, are located at least 750 feet from *livestock structures* that are used by other parts of the *livestock facility*.

"Substantially altered" livestock structure – A *livestock structure* that undergoes a material change in construction or use such as:

- An increase in the capacity of a *waste storage facility.*
- The addition of a liner to a *waste storage facility.*
- An increase of more than 20% in the area or capacity of a *livestock structure* used to house, feed, or confine *livestock* or to store livestock feed.
- An increase of more than 20% in the number of *animal units* that will be kept in a *livestock structure* on at least 90 days in any 12− month period.

"Waste storage structure" – An embankment structure, excavated pit, dugout or fabricated structure that is used to store manure, milking center waste or other organic waste generated by a *livestock facility.* For the purposes of waste storage structure setback (application form, A−2) and worksheet 2, a "waste storage structure" does not include a structure used to collect and store waste under an animal housing facility, or a manure digester consisting of a sealed structure in which manure is subjected to managed biological decomposition.

"Waste storage facility" −− A *waste storage structure* and any attached piping or equipment used to load or unload the structure.

"Winter grazing area" – Cropland or *pasture* where *livestock* feed on dormant vegetation or crop residue, with or without supplementary feed, during the period October 1 to April 30. "Winter grazing area" does *not* include any of the following:

- An area, other than a *pasture*, where *livestock* are kept during the period from May 1 to September 30.
- An area which at any time has an average of more than 4 *animal units* per acre.
- An area from which *livestock* have unrestricted access to navigable waters of the state.
- An area in which manure deposited by *livestock* causes nutrient levels to exceed standards in *ATCP 51.16*.

"WPDES permit" – Wisconsin Pollutant Discharge Elimination System permit issued by DNR for a concentrated animal feeding operation over 1000 *animal units,* or for operations of any size that discharge pollutants directly to waters of the state.

arm−lwr− 11/04 January, 2006

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708−8911
Phone: (608) 224−4622 or (608) 224−4500

Application for Local Approval

New or Expanded Livestock Facility

Wis. Statutes s. 93.90
Wis. Adm. Code ch. ATCP 51

1. Legal Name of Applicant (Business Entity): Emerald Sky Dairy, LLC

2. Type of Business Entity: check one

☐ Individual	☐ Corporation	☐ Partnership	☐ Cooperative	☒ LLC
☐ Trust	☐ Other	Describe:		

3. Other names, if any, under which applicant does business (list all):

4. Contact Individual: Name: Todd Tuls

Phone: 402-526-2385 E−mail: todd@tulsdairies.com

5. Business Address: Street Address: 2670 D Road

City/Village/Town:	County:	State:	Zip:
Rising City, NE	Butler	NE	68658

6. Principal Owners or Officers (list if applicant is an entity other than an individual):

Name: Same as Above	Title:	Phone:	
Address:	City:	State:	Zip:
Name:	Title:	Phone:	
Address:	City:	State:	Zip:
Name:	Title:	Phone:	
Address:	City:	State:	Zip:

7. Description of Proposed *Livestock Facility*

Check one: ☐ New *Livestock Facility* ☒ *Expanded Livestock Facility* Premises ID:

Address of Proposed *Livestock Facility*: 2487 County Highway G

City/Village/Town:	County:	State:	Zip:
Emerald	St Croix	WI	54013

Town #	Range # (E or W)	Section #	¼ Section #
30N	16W	22	NE

Application (continued)

8. Total *Animal Units*

Enter total *animal units* from **worksheet 1:**

Total *Animal Units*: 2725. This is the maximum *livestock facility* size for which the applicant requests approval at this time.

9. Area Map of *Livestock Facility*

Attach a scale map or aerial photo of the proposed *livestock facility* and surrounding area. The map or photo must be appropriately sized and marked, so that it clearly and legibly shows all of the following:

- All existing and proposed *livestock structures*. Label each *livestock structure* to show structure type, and whether existing or proposed.
- The area lying within 2 miles of any of the *livestock structures*. Show all existing buildings, property lines, roadways, and navigable waters lying within that area.
- All residences and *high use buildings* within 2500 ft. of any *livestock structure*. Show which (if any) of those buildings are owned by the applicant, or by persons who have agreed to exclude the buildings from the applicant's odor worksheet calculations.
- Topographic lines at 10 ft. elevation intervals.
- Map scale and north direction indicator.

10. Site Map of *Livestock Facility*

Attach a scale map or aerial photo of the proposed *livestock facility* site. The map or photo shall be appropriately sized and marked, so that it clearly and legibly shows all of the following:

- All existing and proposed *livestock structures*. Label each *livestock structure* to show structure type, and whether existing or proposed.
- The area lying within 1,000 ft. of any of the *livestock structures*. Show all existing buildings, property lines, roadways, navigable waters, and known *karst features* within that area.
- Topographic lines, at 2 ft. elevation intervals, for the area within 300 feet of the *livestock structures*.
- Map scale and north direction indicator.

11. Location of *Livestock Structures*

The applicant certifies that:

- All *livestock structures* comply with applicable local property line and road setbacks (see *ATCP 51.12).*
- All *waste storage structures* comply with setbacks in *ATCP 51.12(2).*
- All *livestock structures* comply with applicable local shoreland, wetland, and floodplain zoning ordinances (copies available from local government).
- Wells comply with the Wisconsin well code (*NR 811* and *812*). *New or substantially altered livestock structures* are separated from existing wells (including neighbors' wells) by setback distances required in *NR 811* and *812*.

Application (continued)

12. Employee Training Plan

Attach an Employee Training Plan for employees who will work at the *livestock facility.* Applicant determines plan contents, as long as the plan identifies all of the following:

- Training topics including, at a minimum, nutrient management, odor management, runoff management, manure and waste handling, employee safety, and environmental incident response.
- The number and job categories of employees to be trained.
- The form and frequency of training, which at a minimum must include a plan for at least one training per year.
- Training presenters (these may include *livestock facility* managers, consultants or professional educators).
- A system for taking and recording attendance.

13. Environmental Incident Response Plan

Attach an Environmental Incident Response Plan for the *livestock facility.* Applicant determines plans contents, as long as the plan identifies all of the following:

- Types of environmental incidents covered. These must include, at a minimum, overflows and spills from waste storage facilities, catastrophic system failures, manure spills during transport and application, movement of manure during or after application, catastrophic mortality disposal emergency, and odor complaints.
- The name and business telephone number of at least one individual who will handle public questions and concerns related to environmental incidents.
- The names and telephone numbers of first responders (e.g. DNR, fire departments, excavation contractors).
- Incident response procedures, including emergency response, recordkeeping and reporting procedures.

14. Odor Management Plan (*Optional*)

An applicant required to complete the odor management worksheet may attach an *optional* odor management plan. The applicant determines plan contents, as long as the plan addresses all of the following: activities to reduce community conflict; practices used to reduce dust; practices used to reduce odor from feed storage leachate; practices used to conserve water; and practices used to reduce odor from dead animals**.**

Application (continued)

15. Other Laws

The following laws, among others, may apply to the operation of a *livestock facility*. Local approval of a *livestock facility* siting application is NOT based on these laws, except as specifically provided in *ATCP 51*. However, violations may have other legal consequences:

- Soil conservation and nonpoint pollution laws (contact your county land conservation department). Livestock facilities that have 1,000 or more animal units, or that discharge pollutants directly to waters of the state, must also obtain a *WPDES permit* from *DNR*.
- Pesticide and agricultural chemical laws administered by *DATCP*.
- Animal disease control laws administered by *DATCP*.
- Animal mortality laws administered by *DATCP*.
- Vehicle weight limits and state prohibitions against spilling waste on roads.
- Food safety and animal health licenses administered by *DATCP*. All livestock operations must register, and some (such as dairy farms) must hold a state license.
- Air pollution control regulations administered by *DNR*.
- Building, electrical, plumbing and sanitation codes administered by the Wisconsin Department of Safety and Professional Services. A local authority may disapprove a proposed *livestock facility* that violates a conforming local code.
- Construction site erosion control laws administered by *DNR*.
- Local erosion control and stormwater management ordinances.
- Petroleum storage laws administered by the Wisconsin Department of Safety and Professional Services.
- High capacity well regulations administered by *DNR*.

16. Worksheets

Complete worksheets as required (follow instructions on each worksheet) and attach to application.

Worksheet 1 – **Animal Units**.

Worksheet 2 – **Odor Management**.

Worksheet 3 – **Waste and Nutrient Management**. If you hold a *WPDES permit* from *DNR* for the same proposed *livestock facility* (for an equal or greater number of *animal units*), check the appropriate box on this worksheet, and submit a copy of the permit with this application.

Worksheet 4 – **Waste Storage Facilities**. If you hold a *WPDES permit* from *DNR* for the same proposed *livestock facility* (for an equal or greater number of *animal units*), check the appropriate box on this worksheet, and submit a copy of the permit with this application.

Worksheet 5 – **Runoff Management**. If you hold a *WPDES permit* from *DNR* for the same proposed *livestock facility* (for an equal or greater number of *animal units*), check the appropriate box on this worksheet, and submit a copy of the permit with this application.

Application (continued)
Authorized Signature: *I certify that the information contained in this application (including worksheets and all attachments) is complete and accurate to the best of my knowledge.* Signature of Applicant or Authorized Representative — Date: 8-10-17 Print Name: Ronnie Williams — Title: PE / Authorized Rep.
For Office Use Only:
Application #:
Date Application Received:
Date Completeness Determined: — **Date Notice Sent to Applicant:**
Date Notice Sent to Adjacent Landowners:
Decision Date:
Approved or Disapproved:
Date Appeal Filed (if any):

arm–lwr–11/04 January 2006

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708–8911
Phone: (608) 224–4622 or (608) 224–4500

Worksheet 1 – *Animal Units*

Instructions: Use this worksheet to determine the number of *animal units* for which you request approval. You may request approval for a number that is large enough to accommodate current and potential future expansions. If the local government approves the requested number of *animal units*, that is the maximum number that you may keep for 90 days or more in any 12–month period. You may not exceed that number without additional approval.

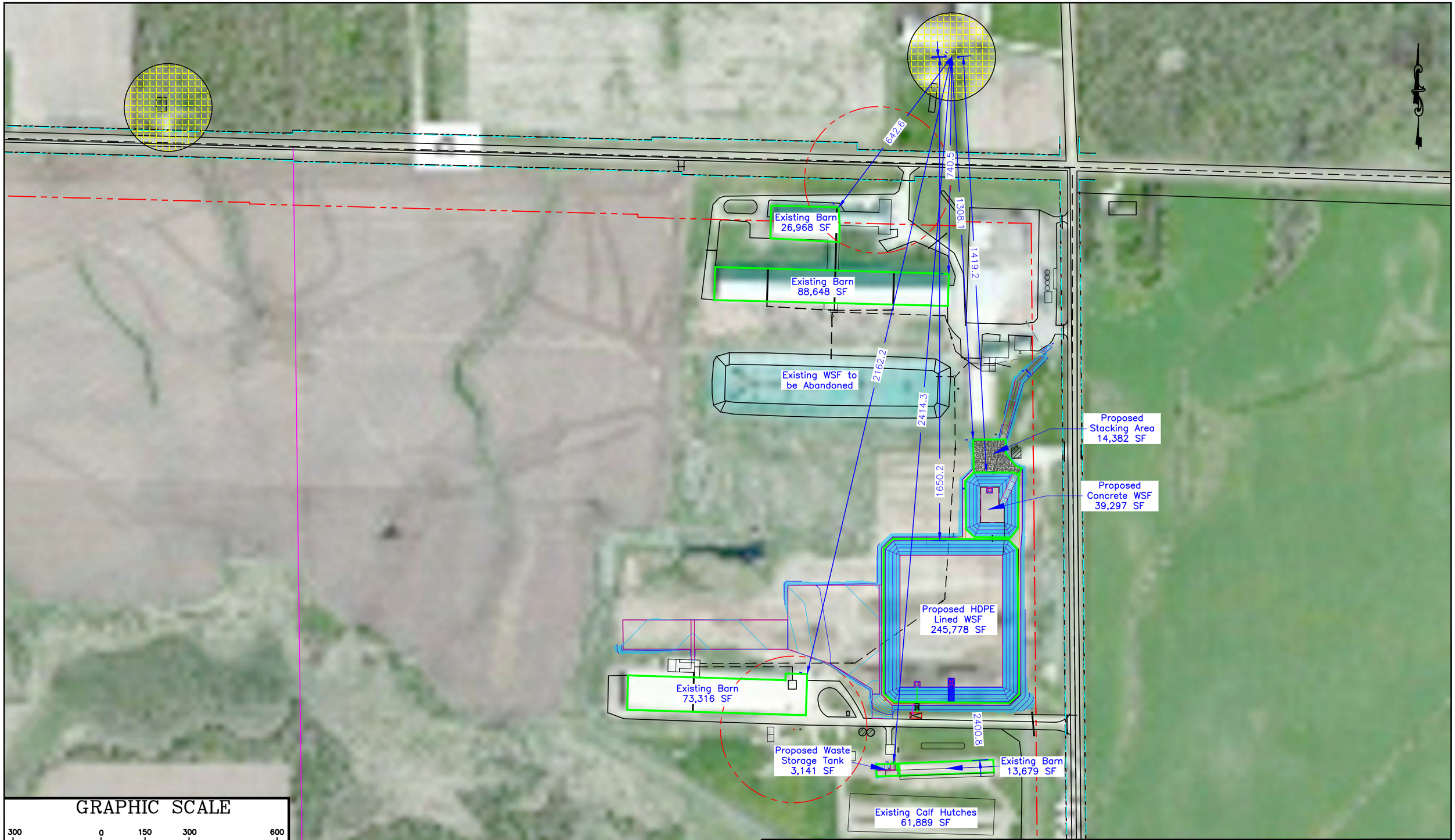
To complete this worksheet:

1. Identify each type of *livestock* that you might keep at the proposed facility. Enter the maximum number of animals of each type that you might keep for at least 90 days in any 12–month period.
2. Multiply the number of animals of each type by the relevant Animal Unit Factor to obtain *animal units* of each type.
3. Sum the *animal units* for all *livestock* types to obtain the Total *Animal Units* for which you request approval.

	***Livestock* Type**	**Animal Unit Factor**	***Animal Units* For Proposed Facility**
Example – Milking & Dry Cows			*1.4 x 800 = 1120 AU*
Dairy Cattle	Milking and Dry Cows	**1.4**	1.4 x 1700 = 2380
	Heifers (800 lbs. to 1200 lbs.)	**1.1**	1.1 x 250 = 275
	Heifers (400 lbs. to 800 lbs.)	**0.6**	0.6 x =
	Calves (up to 400 lbs.)	**0.2**	0.2 x 350 = 70
Beef	Steers or Cows (600 lbs. to market)	**1.0**	1.0 x =
	Calves (under 600 lbs.)	**0.5**	0.5 x =
	Bulls (each)	**1.4**	1.4 x =
Swine	Pigs (55 lbs. to market)	**0.4**	0.4 x =
	Pigs (up to 55 lbs.)	**0.1**	0.1 x =
	Sows (each)	**0.4**	0.4 x =
	Boars (each)	**0.5**	0.5 x =
Poultry	Layers (each)	**0.01**	0.01 x =
	Broilers (each)	**0.005**	0.005 x =
	Broilers – continuous overflow watering	**0.01**	0.01 x =
	Layers or Broilers – liquid manure system	**0.033**	0.033 x =
	Ducks – wet lot (each)	**0.2**	0.2 x =
	Ducks – dry lot (each)	**0.01**	0.01 x =
	Turkeys (each)	**0.018**	0.018 x =
Sheep (each)		**0.1**	0.1 x =
Goats (each)		**0.1**	0.1 x =
Total *Animal Units* for Which Applicant Requests Approval			= 2725

Signature of Applicant or Authorized Representative

8-10-17
Date



GRAPHIC SCALE

300 0 150 300 600

(IN FEET)

1 inch = 300 ft.

1 inch = 300 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Proposed Site
Odor Score Siting

Emerald Sky Dairy, LLC

7/10/2017

Arm–lwr–11/04 January 2006

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708–8911
Phone: (608) 224–4622 or (608) 224–4500

Worksheet 2 – Odor Management

Instructions: This worksheet addresses odor from *livestock structures*. You are NOT required to complete this worksheet if any of the following apply (check box if applicable):

☐ I am requesting approval for a *new livestock facility* with fewer than 500 *animal units*.

☐ I am requesting approval for an *expanded livestock facility* with fewer than 1,000 *animal units*.

☐ All *livestock structures* will be at least 2500 ft. from the nearest affected neighbor.

If you checked any of the above boxes, just sign below and submit this page with your application. If you did NOT check any of the above boxes, you must complete this worksheet to calculate the odor score (Box 4) for your proposed *livestock facility*. To meet the odor management standard, you must have a total odor score of 500 or more.

If *livestock structures* are located in *clusters* that are separated by more than 750 feet, you may elect to complete a separate worksheet for each *cluster*. If you choose that option, each *cluster* must meet the odor management standard.

A complete worksheet must include Tables A and B. You may use a convenient automated spreadsheet in place of Tables A and B if you prefer (submit spreadsheet output instead of tables, results will be identical). However, you must still sign and submit this signature page. The spreadsheet is available at the *DATCP* website, http://www.datcp.state.wi.us.

TO COMPLETE THIS WORKSHEET, FOLLOW THESE STEPS:

Step 1: Complete Table A to determine the Predicted Odor from your *livestock structures*. Enter the Predicted Odor in Box 3 below (NOT Box 1).

Step 2: Complete Table B to determine your Separation Score. Enter your Separation Score in Box 1 below. (NOT Box 2).

Step 3: Enter your management credits in Box 2 (maximum 100 points). All applicants may enter 80 points for completing required incident response and employee training plans (described on page A–3). Applicants completing an optional odor management plan (described on page A–3), may add an additional 20 points. Applicants determine plan contents, as long as the plan addresses the required topics.

Step 4: Add Box 1 and Box 2. Subtract Box 3 and enter the total in Box 4. This is your Odor Score.

Box 1		Box 2		Box 3		Box 4
810	+	80	–	382	=	508
Separation Score (from Step 2)		**Management Score** (from Step 3)		**Predicted Odor** (from Step 1)		**Odor Score**

A local government must approve a *livestock facility* with an odor score of 500 or more (Box 4). You may add odor control practices to increase your odor score to 500 or more. A local government may approve, but is not required to approve, a *livestock facility* with an odor score less than 500 but not less than 470.

Signature of Applicant or Authorized Representative

8-10-17
Date

TABLE A: Predicted Odor from *Livestock Structures*

Worksheet 2 (continued)

Instructions: Complete Table A. You must measure all structures to the same affected neighbor. If the nearest neighbor is not the same for all livestock structures, you will need to complete the table once for each close neighbor. Compare the "H" Total of the table for each neighbor. The neighbor that has the lowest weighted distance is considered your nearest affected neighbor, and you should use that table to complete the odor worksheet. Enter the Column F total on page A-6 in **Box 3.** Enter the Column G result on page A-8 in **Table B, Step 1**. Add lines or use additional sheet, if needed, to list all structures.

Option 1

1. *Animal Housing Areas* – List each

Column A **Manure Management Type** Enter your housing buildings and the related 4-letter code from Chart 2. You may exclude up to 1000 calf hutches and 4 structures less than the sq. footage listed in Chart 2.	Column B **Odor Generation Number** From Chart 2	Column C **Housing Area** (Ft^2) Use occupied animal area only. Exclude feed alleys, holding areas and milking parlors. Express in 10,000s. (Ex: 15,523 ft^2 = 1.55)	Column D **Odor Control Practice Codes** List all that apply to each housing area, from Chart 3	Column E **Multiplier for Odor Control Practice** List all that apply to Each from Chart 3. Enter "1" if none.	Column F **Predicted Odor** Multiply columns B, C, and E	Column G **Distance to Nearest *Affected Neighbor(ft)*** Measure from corner of the bldg to corner of the neighbor's bldg. Measure all to the same neighbor.	Column H **Weighted Distance (ft.)** Multiply columns F & G
1A.. DBSC	4	2.70	A1 B4 D1	0.8 0.7 0.9	5.44	643	3,498
1B. DBSC	4	8.86	A1 B4 D1	0.8 0.7 0.9	17.86	741	13,234
1C. DBSC	4	7.33	A1 B4 D1	0.8 0.7 0.9	14.78	2162	31,954
1D. DBSC	4	1.37	A1 B4 D1	0.8 0.7 0.9	2.76	2401	6,627
1E.							

2. *Waste Storage Facilities* – List each

Column A **Waste Storage Type** Enter 4-letter type code from Chart 2	Column B **Odor Generation Number** From Chart 2	Column C **Exposed Surface Area** Measure surface area (ft^2) when pit is filled to capacity, excluding freeboard. Enter in 10,000's. (Ex: 75,575 = 7.56)	Column D **Odor Control Practice Codes** List all that apply to each facility from Chart 3	Column E **Multiplier for Odor Control Practice** List all that apply to each from Chart 3. Enter "1" if none.	Column F **Predicted Odor** Multiply columns B, C, and E	Column G **Distance to Nearest *Affected Neighbor (ft)*** Measure from top inside edge to neighbor's bldg corner. Measure to the same neighbor.	Column H **Weighted Distance (ft.)** Multiply columns F & G
2A. WSLT	13	3.93	F5	0.3	15.33	1420	21,769
2B. WSLT	13	24.58		1	319.54	1650	527,241
2C. WSSS	2	1.43		1	2.86	1308	3,741
2D. WSST	28	0.14		1	3.92	2414	9,463

3. *Animal Lots* – List each

Column A **Animal Lot Type** Enter 4-letter type code from Chart 2	Column B **Odor Generation Number** From Chart 2	Column C **Animal Lot Area** (ft^2) Enter in 10,000's (Ex: 7438 = .74)	Column D **Odor Control Practice Codes** List all that apply to each facility from Chart 3	Column E **Multiplier for Odor Control Practice** List all that apply to each from Chart 3. Enter "1" if none.	Column F **Predicted Odor** Multiply columns B, C, and E	Column G **Distance to Nearest *Affected Neighbor(ft)*** Measure from corner to corner. Measure all structures to the same neighbor.	Column H **Weighted Distance (ft.)** Multiply columns F & G
3A.							
3B.							
3C.							
					382.49 **F Total**	1614 **G = (H Total) ÷ (F Total)**	617,527 **H Total**
					Enter on page A-6, **Box 3**	Enter on page A-8, **Table B, Step 1**	

Worksheet 2 (continued)

Table B: Separation Score

INSTRUCTIONS	RESULTS
Step 1: Enter, at right, the result from Table A, Column G (page A−7).	**Distance (ft.) to Nearest *Affected Neighbor*:** 1614
Step 2: Select multiplier based on the compass direction looking from the *livestock facility* to the nearest *affected neighbor*. Enter at right.	**Multiplier:** 1.0
Step 3: Calculate wind−adjusted separation distance (Distance to nearest *affected neighbor* x multiplier). Enter at right.	**Wind−Adjusted Separation Distance (ft.)** 1614
Step 4: Determine *affected neighbor* density and enter at right: *Low density* = No more than 5 residences and no *high−use buildings* within 1300 ft of each structure. *High density* = 6 or more residences or at least one *high−use building* within 1300 ft of each structure.	**Low or High Density?** Low
Step 5: Use results above and Chart 1 to find your Separation Score. Enter at right and on Page A−6 in **Box 1**.	**Separation Score** 810

Compass Direction	Multiplier
North	1.0
Northeast	1.0
East	1.1
Southeast	1.2
South	1.2
Southwest	1.2
West	1.3
Northwest	1.1

Chart 1: Separation Score

Wind−Adjusted Separation Distance (ft.)	Low Density	High Density
0−99	505	503
100−149	506	504
150−199	511	507
200−249	516	510
250−299	521	514
300−349	527	518
350−399	534	523
400−449	541	528
450−499	548	533
500−599	560	542
600−699	577	555
700−799	595	569
800−899	615	585
900−999	636	601
1000−1099	658	619
1100−1199	681	637
1200−1299	705	657
1300−1399	730	
1400−1499	756	
1500−1599	783	
1600−1699	810	
1700−1799	839	
1800−1899	868	
1900−1999	899	
2000−2099	930	
2100−2199	962	
2200−2299	994	
2300−2399	1027	
2400−2499	1061	
2500−2749	1123	
2750−2999	1214	
3000−3249	1309	

Worksheet 2 (continued)

Chart 2: Odor Generation Numbers

Animal Housing Area Type	Housing/ Management Type Code	Manure Management Method	Odor Generation Number	Exempt Buildings Maximum Size (ft^2) *(May exclude up to 4)*
Dairy Stanchion	DSDC	Daily to weekly cleaning	2	7500
Dairy Free Stall and Beef & Dairy Heifers (Forage Ration)	DBSS	Slatted floor (includes floor and pit below)	6	2500
	DBSC	Scrape	4	3500
	DBAF	Alley flush to storage	10	1500
	DBBP	Bedded pack	2	7500
Beef Finishing (High Energy Ration)	BFSF	Slatted floor (includes floor and pit below)	12	1000
	BFSC	Scrape	8	2000
	BFBP	Bedded pack	4	3500
Pork Gestation/ Farrow/Nursery	PGSF	Slatted floor (includes floor and pit below)	46	N/A
	PGPP	Pull plug to storage	22	N/A
Pork Finishing	PFSF	Slatted floor (includes floor and pit below)	34	N/A
	PFPP	Pull plug to storage	20	N/A
	PFSS	Scrape systems to storage	11	1500
	PFDB	Deep bedded	4	3500
Poultry	PBLT	Broiler (litter)	1	15000
	PDLQ	Ducks (liquid)	20	N/A
	PLAY	Layers	20	N/A
	PTDL	Turkey and Ducks (litter)	2	7500

Type Codes	*Waste Storage Facility* Types *Note: Storage under slatted floor is addressed under animal housing.*	Odor Generation Number
WSSS	Solid (stack)	2
WSLT	Long term (6 months or longer as determined in Column E of worksheet 3)	13
WSST	Short term (less than 6 months as determined in Column E of worksheet 3)	28

Animal Lot Codes	*Animal Lot* Types		Odor Generation Number
ALPV	**Paved**		4
UPDB	**Unpaved**	Dairy/Beef/Sheep/Goats	6
UPSW		Swine/Poultry	11

Worksheet 2 (continued)

Chart 3: Odor Control Practices

Category	Practice Code	Practice Name (Practices must meet specifications on pages A−11 to A−13)	Multiplier*
Animal Housing Area			
A	A1	Diet manipulation	0.8
B (Choose only 1)	B1	Bio−filter	0.1
	B2	Vegetable oil sprinkling (for swine only)	0.4
	B3	Fresh water flush	0.4
	B4	Treated water flush	0.7
	B5	Air Dam (for swine only)	0.9
C	C1	Windbreak (includes man−made berms)	0.9
D	D1	Frequent cleaning of animal housing area	0.9
Waste Storage Facilities			
E (Choose only 1)	E1	Anaerobic digestion	0.2
	E2	Chemical or biological additives	0.8
	E3	Compost	0.2
	E4	Solids Separation and Reduction	0.6
	E5	Water Treatment	0.1
F (Choose only 1)	F1	Aeration	0.3
	F2	Bio−cover	0.4
	F3	Geotextile cover	0.5
	F4	Impermeable cover	0.1
	F5	Natural crust	0.3
	F6	Bottom fill	0.9
G	G1	Windbreak (includes man−made berms)	0.9
Animal Lots			
H (Choose only 1)	H1	Frequent cleaning of *animal lot*	0.4
	H2	Drag *animal lot*	0.5
I	I1	*Animal lot* moisture control	0.8
J	J1	Windbreak (includes man−made berms)	0.9

*Smaller multiplier = more odor controlled (e.g. a multiplier of 0.4 represents a 60% control).

Innovative Odor Control Practices (all odor sources):
You may take credit for odor control practices not listed in Chart 3 if *DATCP* pre−approves a multiplier for each of those practices. Follow the procedure in *ATCP 51.14(5)(c)* to obtain *DATCP* approval. If you obtain *DATCP* approval, you may include the approved practice and multiplier in odor worksheet calculations in the same manner as for odor control practices listed in Chart 3 (attach *DATCP* approval to your application).

Worksheet 2 (continued)

Odor Control Practice Specifications

Odor control practices identified in Chart 3 must meet the following specifications:

Animal Housing

Diet manipulation (A1) – Limit protein in animal diet by one of the following means:

- Match nutrient supply with animal requirements.
- Formulate low−protein amino acid supplemented diets.
- Add phytase enzyme ingredients.
- Process ingredients in ways that limit protein content of processed feed.
- Use phase feeding.
- Use split sex feeding.
- Minimize feed wastage.

Bio−filter (B1) – Vent air from *animal housing areas* through a bio−filter consisting of compost and wood chips, mixed at a rate of 30:70 to 50:50 (ratio by weight of compost to wood chips). The mixture must be at least 40% moisture by weight. The bio−filter must be 10" to 18" thick, and must have an area of at least 50 to 85 sq. ft. per 1000 cu. ft. per minute (cfm) of airflow.

Vegetable oil sprinkling (B2) – Sprinkle vegetable oil on floors in *animal housing areas* (swine) each day. Apply oil at start−up rate of approximately 40 milliliters per square meter per day (mL/m^2−day) in the first 1−2 days of each production cycle. During the remainder of each production cycle, apply oil at maintenance rate of 5 mL/m^2−day. Avoid oil applications to pens near fans, to areas near heaters, and to areas surrounding feeders.

Fresh water flush (B3) – Use fresh water to flush manure from floors of *animal housing areas* into collection or *waste storage structures*. Flush at least 3 times a day, and more often if necessary, to prevent manure from drying and sticking to floors. Flush must be adequate to remove manure solids effectively.

Treated water flush (B4) – Use treated manure effluent to flush manure from floors of *animal housing areas* into collection or *waste storage structures*. Flush at least 3 times a day, and more often if necessary, to prevent manure from drying and sticking to floors. Flush with waste storage effluent treated by one of the following means:

- *Solids Separation and Reduction (see E4 below).*
- *Aeration (see F1 below).*
- *Anaerobic digestion (see E1 below).*

Air Dam (B5) – Erect and maintain a wall (typically a 10−foot x 10−foot pipe frame and tarpaulin) placed at the end of a swine−finishing building, immediately downwind of the exhaust to deflect air and odor plume. Replace material used for the barriers (tarpaulins on a frame of solid wood, for example) as needed, which may be from a few years to decades, depending on the material.

Windbreak (C1) – Maintain a solid or porous windbreak, 10 to 50 feet from the odor source, which reduces forward momentum of airflow and vertically disperses the odor plume. The length of a windbreak shall be at least half of the perimeter of the animal housing. A windbreak may be constructed of vegetation or other materials. Vegetation windbreaks must contain at least 3 rows of trees and shrubs, of both fast and slow−growing species, that are well suited for the site. Windbreaks must be designed and constructed according to *NRCS* Technical Guide Standard 380 (June, 2002).

Frequent cleaning of animal housing area (D1) – Scrape and remove manure from *animal housing areas* at least 3 times a day.

Worksheet 2 (continued)

Waste Storage Facilities

Anaerobic digestion (E1) – Subject manure to managed biological decomposition within a sealed oxygen−free container ("digester"). Anaerobic digestion must meet design and operational standards necessary to achieve adequate odor control, including requirements for solids concentration, flow rates, retention time, and minimum temperatures. Systems must meet the following:

- *Plug flow digester.* Treats manure with a total solids concentration of 8 to 14%. Must be kept in the digester for at least 20 days at a temperature of 95° to 104° F. (35° to 40° C). The digester's ratio of flow path width to fluid depth must be between 3.5:1 and 5:1.
- *Complete mix digester.* Treats manure with a total solids concentration of 2.5 to 10%. Must be kept in the digester for at least 17 days at a temperature of 95° to 104° F. (35° to 40° C.). The digester must have appropriate mixing devices to ensure complete mixing.
- *Fixed film digester.* Treats manure with a total solids concentration of not more than 5%. Must be kept in the digester for 1 to 6 days at a temperature of 59° to 99° F (15° to 39° C). Microbial support material must have at least 3−inch openings.
- *Other systems.* Use proprietary design and performance specifications that are commonly accepted and provide adequate odor mitigation.

Chemical or biological additives (E2) – Apply, to stored manure, chemical or biological additives that are scientifically proven to be effective in reducing odor from that manure when applied under applicable conditions and in applicable amounts.

Compost (E3) – Aerobically treat solid or semi−solid manure to create compost. Compost must have a carbon: nitrogen ratio of 25:1 to 40:1, and must consist of at least 40 to 60% moisture by weight. Composted material must be held at a temperature of more than 130° F. (54° C.) for more than 5 days.

Solids Separation and Reduction (E4) – Reduce the solid content of stored manure to an average of less than 2% solids through separation, multi−tiered pits or other means.

Water Treatment (E5) – Install and use a physical, chemical or biological process that removes the majority of contaminants from the waste stream, resulting in a liquid effluent meeting surface water discharge standards. The remaining solid fraction or sludge must be accounted for based on its form, and the management it is subject to.

Aeration (F1) – Use aeration equipment to maintain aerobic activity in stored manure. Aeration must maintain an average of 2 milligrams of dissolved oxygen per liter of manure stored in the upper foot of manure stored in the aerated structure between April and October.

Bio−cover (F2) – Cover the surface of waste storage structure with an 8″ to 12″ thick blanket of dry wheat, barley or good quality straw. The blanket must cover nearly all of the waste surface between the months of April and October. Add to the blanket as necessary (typically every 6 weeks to 4 months) to maintain the required cover.

Geotextile cover (F3) – Cover the surface of waste storage structure with a geotextile membrane that is at least 2.4 mm thick. The membrane must cover nearly all of waste surface between the months of April and October.

Impermeable cover (F4) – Cover the surface of waste storage structure with an impermeable barrier that prevents gas from escaping. Gas must be drawn off, and either treated or burned.

Natural crust (F5) – Maintain a natural crust of dry manure on the surface of stored manure. The natural crust must cover a substantial amount of the surface area of the stored manure, for most of the time between the months of April and October.

Bottom fill (F6) – Add manure to a liquid *manure storage structure* from the bottom so as to limit disturbance to the surface of the stored manure.

Windbreak (G1) – Maintain a solid or porous windbreak, 10 to 50 feet from the odor source, which reduces forward momentum of airflow and vertically disperses the odor plume. The length of a windbreak shall be at least half of the perimeter of the *waste storage facility.* A windbreak may be constructed of vegetation or other materials. Vegetation windbreaks must contain at least 3 rows of trees and shrubs, of both fast and slow−growing species, that are well suited for the site. Windbreaks must be designed and constructed according to *NRCS* Technical Guide Standard 380 (June, 2002).

Worksheet 2 (continued)

Animal Lots

Frequent cleaning of *animal lot* (H1) – Scrape and remove manure from *animal lot* surfaces at least once every 3 days. You may leave an undisturbed, compacted manure layer (1 to 2 inches thick) on the surface of unpaved *animal lots* to provide good surface sealing.

Drag *animal lot* (H2) – Drag manure in *animal lots* with harrow or disk at least once every 7 days during the months of April though October, to aerate and dry the manure.

***Animal lot* moisture control (I1)** – Prevent runoff water from flowing onto *animal lots* from roofs and other surfaces. Use diversions or roof runoff systems identified in *s. ATCP 50.70 or 50.85*. *Animal lots* must have a grade of at least one percent to promote drainage and drying.

Windbreak (J1) ─ Maintain a solid or porous windbreak, 10 to 50 feet from the odor source, which reduces forward momentum of airflow and vertically disperses the odor plume. The length of a windbreak shall be at least half of the perimeter of the *animal lot*. A windbreak may be constructed of vegetation or other materials. Vegetation windbreaks must contain at least 3 rows of trees and shrubs, of both fast and slow−growing species, that are well suited for the site. Windbreaks must be designed and constructed according to *NRCS* Technical Guide Standard 380 (June, 2002).

Arm–lwr– 11/04 January 2006

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708–8911
Phone: (608) 224–4622 or (608) 224–4500

Worksheet 3 – Waste and Nutrient Management

Part A. Waste Generation and Storage Summary

Instructions: You must complete Parts A and B of this worksheet. If your *livestock facility* will have fewer than 500 *animal units* you may be exempt from Part C, depending on results of Part B. If Part C applies, it must be signed by a *qualified nutrient management planner* (you must also sign).

You are NOT required to complete this worksheet if you already hold a *WPDES permit* for the proposed *livestock facility* (for the same or greater number of *animal units*). Simply check the following box, sign at the bottom of this page, and include a copy of the *WPDES permit* with your application.

☐ I enclose a copy of my *WPDES permit* in place of Worksheet 3.

Specify a single livestock type (dairy, beef, swine, etc.). *Use a separate worksheet for each livestock type.*

Livestock Type: _____

Description of Storage	Column A Waste Storage Capacity (Gallons or Tons)	Column B Source of Waste (Animal Waste, Wastewater, Leachate, etc.)	Column C Average Annual Volume of Waste Produced from Each Source (Gallons or Tons)	Column D Total Average Annual Volume Waste Produced (Gallons or Tons)	Column E Storage Duration in Days (Column A divided by Column D times 365 days)
Example: Unit 1 – lagoon	*5,000,000 gallons*	*Animal waste*	*4,000,000 gallons*	*7,000,000 gallons*	*260 days*
		Wastewater	*1,000,000 gallons*		
		Leachate	*2,000,000 gallons*		
2-Stage WSF Concrete/HDPE Pond	*30,105,489 gallons*	*Animal waste*	*16,231,039 gallons*	*28,968,977 gallons*	*378 days*
		Wastewater	*4,964,000 gallons*		
		Contaminated Runoff	*7,773,958 gallons*		

Applicant affirms that the information provided in Part A is accurate.

Signature of Applicant or Authorized Representative — Date: 8-10-17

Worksheet 3 (continued)

Arm-lwr- 11/04 January 2006

Part B – Land Base for Applying Nutrients

1. Enter total *animal units* in proposed *livestock facility* (**from worksheet 1**): 2725

2. What percentage of the waste from the *livestock facility* will be:
   a. Applied to land: 100 %. Attach map showing where waste will be applied to land.
   b. Processed and sold as commercial fertilizer, under a fertilizer license: _____%.
   c. Disposed of in other ways: _____%. Describe ways: _____

3. Multiply the percent in line 2a by the number of *animal units* in line 1. Result (# of *animal units*): 2725

4. Total acres of cropland currently available for land application (owned, rented, or landspreading agreement): 5,210.2

5. Divide # of acres in line 4 by # of *animal units* in line 3 to obtain ratio of acres to *animal units*: 1.9

6. Is the ratio in line 5 equal to or greater than the applicable ratio in Table 1? Yes

   If YES, and if the # of *animal units* in line 1 is less than 500, you need NOT complete Part C. Otherwise, complete Part C.

Table 1: Acreage per *Animal Unit*

Animal Type	Acres per *Animal Unit**
Dairy	1.5
Beef	1.5
Swine	1.0
Chickens/Ducks	2.5
Turkeys	5.5
Sheep/Goats	2.0

* NOTE: A *livestock facility* is NOT required to attain or exceed this ratio of acres to *animal units*. But IF your *livestock facility* will attain or exceed this ratio and will have fewer than 500 *animal units*, you need NOT complete Part C of this worksheet.

Applicant affirms that the information provided in Part B is accurate.

Signature of Applicant or Authorized Representative — Date: 8-10-17

Worksheet 3 (continued)

arm–lwr– 11/04 January 2006

Part C – Nutrient Management Checklist

Instructions: All applicants must submit this checklist unless exempted under Part A or B. The checklist is based on the *NRCS* Technical Guide Nutrient Management Standard 590 (September, 2005).

County Name: St Croix	Date Submitted:	Township (T. 30 N., S.) – (R. 16 E., W.)
Cropland Acres: (owned, rented, or with manure spreading agreement)	Name of livestock operator submitting checklist:	

	Yes	NA
1. Are the following field features identified on maps or aerial photos?		
a) Field location, soil survey map unit(s), field boundary, and field identification number.		
b) Areas prohibited from receiving nutrient applications: Surface water, established concentrated flow channels with perennial cover, permanent non–harvested vegetative buffer, non–farmed wetlands, sinkholes, lands where established vegetation is not removed, nonmetallic mines, and fields eroding at a rate exceeding tolerable soil loss (T).		
c) Areas within 50 ft of a potable drinking water well where mechanically–applied manure is prohibited.		
d) Areas prohibited from receiving winter nutrient applications: Slopes > 9% (12% if contour–cropped); Surface Water Quality Management Area (SWQMA) defined as land within 1,000 ft of lakes and ponds or within 300 ft of perennial streams draining to these waters, unless manure is deposited through winter gleaning/pasturing of plant residue and not exceeding the N and P requirements of this standard.		
e) Areas where winter applications are restricted unless effectively incorporated within 72 hours: Land contributing runoff within 200 ft upslope of direct conduits to groundwater such as a well, sinkhole, fractured bedrock at the surface, tile inlet, or nonmetallic mine.		
f) Sites vulnerable to N leaching: Areas within 1,000 ft of a municipal well, and soils listed in Appendix 1 of the Conservation Planning Technical Note WI–1.		
2. Are erosion controls implemented so the crop rotation will not exceed T on fields that receive nutrients according to the conservation plan or WI P Index model?		
3. Check the methods below used to determine field soil nutrient levels:		
a) Soil samples were collected and analyzed within the last 4 years according to UW Publication A2100 recommendations.		
b) For fields not meeting (a.) above, soil test phosphorus levels are assumed to be greater than 100 ppm soil test P. *		
c) For fields not meeting (a.) above, preliminary estimates of soil nutrients were determined using limited soil sampling (> 5 acre per sample) but analyzed by a DATCP certified laboratory. *		
*For fields with soil nutrient levels determined under (b) or (c), the applicant must collect and analyze soil samples meeting the requirements of A2100 within 12 months of siting approval, and revise the nutrient management plan accordingly.		
4. Using the field's predominant soil series and realistic yield goals, are planned nutrient application rates, timing, and methods of all forms of N, P, and K listed in the plan and consistent with UW Publication A2809, *Soil Test Recommendations for Field, Vegetable and Fruit Crops*, and the 590 standard?		
5. Do manure production and collection estimates correspond to the acreage needed in the plan? Are manure application rates realistic for the calibrated equipment used?		
6. Is a single phosphorus (P) assessment of either the P Index or soil test P management strategy uniformly applied to all fields within a tract?		
7. Are areas of concentrated flow, resulting in reoccurring gullies, planned to be protected with perennial vegetative cover?		
8. Will nutrient applications on non–frozen soil within the SWQMA comply with the following?		
a) Unincorporated liquid manure on unsaturated soils will be applied according to Table 1 of the 590 standard to minimize runoff.		
b) One or more of the following practices will be used: 1) Install/maintain permanent vegetative buffers, or 2) Maintain greater than 30% crop residue or vegetative coverage on the surface after nutrient application, or 3) Incorporate nutrients leaving adequate residue to meet tolerable soil loss, or 4) Establish fall cover crops promptly following application.		
9. Is a narrative included which describes proposed manure collection, transportation, and application methods?		

I certify that the documentation supporting this checklist is complete and accurate:

Signature of *Qualified Nutrient Management Planner*, other than applicant: _____

(qualified by 1. NAICC–CPCC, 2. ASA–CCA, 3. ASA–Professional Agronomist, 4. SSSA–Soil Scientist)

Signature of Applicant or Authorized Representative: _____

Arm=lwr= 11/04 January 2006

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911
Phone: (608) 224-4622 or (608) 224-4500

Worksheet 4 – *Waste Storage Facilities*

Instructions: This worksheet must be signed by a registered professional engineer or *certified agricultural engineering practitioner.* This worksheet must identify every *waste storage facility* in the proposed *livestock facility* (including storage structures and transfer systems).

You are NOT required to complete this worksheet if you already hold a *WPDES permit* for the proposed *livestock facility* (for the same or greater number of *animal units*). Simply check the following box, sign at the bottom of this page, and include a copy of the *WPDES permit* with your application.

☑ I enclose a copy of my *WPDES permit* in place of Worksheet 4.

***New* or *Substantially Altered* Facilities:** Design specifications for the following *new* or *substantially altered waste storage facilities* comply with *NRCS* Technical Guide Standards 313 (November, 2004) and 634 (November, 2004). [Identify each facility and attach design specifications for each facility.]

Existing Facilities Retained: The following *waste storage facilities* will continue in use without being *substantially altered.* Each facility meets one of the following:

☐ The facility (list each facility _____) was constructed of concrete or steel or both, was constructed within the last 10 years according to then-existing *NRCS* technical standards, and shows no apparent signs of structural failure or significant leakage.

☐ The facility (list each facility _____) was constructed within the last 3 years according to then-existing *NRCS* technical standards, and shows no apparent signs of structural failure or significant leakage.

☐ The facility (list each facility_____) was constructed to *NRCS* technical standards that existed at the time of construction, is in good condition and repair and shows no apparent signs of structural failure or significant leakage.

☐ The facility (list each facilty_____) is in good condition and repair, shows no apparent signs of structural failure or significant leakage, and is located on a site at which the soils and separation distances to groundwater comply with *NRCS* Technical Guide Manure Storage Facility Standard 313, Table 1 (November, 2004).

☐ The facility (list each facility _____) is in good condition and repair, shows no apparent signs of structural failure or significant leakage, is located entirely above ground, and is located on a site at which the soils comply with *NRCS* Technical Guide Manure Storage Facility Standard 313, Table 5 (November, 2004).

Facilities To Be Abandoned: The following *waste storage facilities* will be closed according to a closure plan that complies with *NRCS* Technical Guide Standard 360 (June, 2001). [Attach closure plan for each facility.]

Total Storage Capacity: The *waste storage facilities* in the proposed *livestock facility* have a combined useable storage capacity of _____ gallons or tons (cannot include required "freeboard" in useable capacity).

Ronnie Williams PE 42226
Print Name of Engineer (include WI License No.) or *Certified Agricultural Engineering Practitioner*

Professional Engineer's Embossed Seal

Signature of Engineer or Practitioner

8-10-17
Date

Williams Engineering Services, LLC
Name of Firm and Address

E4910 Bobs Grass Rd
Augusta WI 54722

Arm−lwr− 11/04 January 2006

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708−8911
Phone: (608) 224−4622 or (608) 224−4500

Worksheet 5 − Runoff Management

Instructions: This worksheet must be signed by a registered professional engineer or *certified agricultural engineering practitioner* (you must also sign). Signers attest to statements in this worksheet. You are responsible for compliance.

You are NOT required to complete this worksheet if you already hold a *WPDES permit* for the proposed *livestock facility* (for the same or greater number of *animal units*). Simply check the following box, sign at the bottom of this page, and include a copy of the *WPDES permit* with your application.

☐ I enclose a copy of my *WPDES permit* in place of Worksheet 5.

***Animal Lots*[1]**

1. *New* or *Substantially Altered Animal Lots*: All *new* or *substantially altered animal lots* will be constructed according to the attached design specifications that comply with *NRCS* Technical Guide Standard 635 (January, 2002). [Identify *animal lots* and attach design specifications for each *animal lot*.]

2. Existing *Animal Lots* Near Surface Waters: The following *animal lots* are located within 300 feet of a stream[2] or 1,000 feet of a lake. According to the *BARNY runoff model*, each of these *animal lots* has (or with minor alterations[3] will have) predicted average annual phosphorus runoff of less than 5 lbs. per year (measured at the end of the treatment area). Runoff does not discharge to any direct conduit to groundwater. [Identify *animal lots* and minor alterations if any.]

3. Other Existing *Animal Lots*: The following *animal lots* are NOT located within 300 feet of a stream[2] or 1,000 feet of a lake. According to the *BARNY runoff model*, each *animal lot* has (or with minor alterations[3] will have), a treatment area that reduces phosphorus runoff to an average of less than 15 lbs. per year (measured at the end of the treatment area). Runoff does not discharge to any direct conduit to groundwater. [Identify *animal lots* and minor alterations if any.]

Feed Storage

1. General. The operator agrees to manage feed storage to prevent significant discharge of leachate or polluted runoff to waters of the state.

2. Existing Feed Storage (High Moisture Feed). Existing paved areas and bunkers that may be used to store or handle high moisture feed (70% or higher moisture content) will meet the following standards:

a) Surface water runoff will be diverted from entering the paved area or bunker. [4]

b) Surface discharge of leachate will be collected before it leaves any paved area or bunker, if the paved area covers more than one acre. Collected leachate will be stored and disposed of in a manner that prevents discharge to waters of the state. [5]

[1] Treat multiple lots as one *animal lot* if runoff from the *animals lots* drains to the same treatment area or if runoff from the *animal lot* treatment areas converges or reaches the same surface water within 200 feet of any of those treatment areas.

[2] Indicated by a solid or dashed blue line on a 1:24,000 scale USGS topographic map.

[3] "Minor alterations" are repairs or improvements that do not result in *a substantially altered animal lot.* "Minor alterations" may include conservation practices such as runoff diversions, contouring, and planting vegetation.

[4] Runoff may be diverted by means of earthen diversions, curbs, walls, gutters, waterways or other practices, as appropriate.

[5] Use safe methods to dispose of collected leachate. For example, leachate may be transferred to *waste storage structures* and then applied to land at agronomic rates.

Worksheet 5 (continued)

3. ***New* or *Substantially Altered* Feed Storage Structures (High Moisture Feed):** *New* or *substantially altered* feed storage structures (buildings, silos, bunkers or paved areas) used to store or handle high moisture feed (70% or higher moisture content) will be designed, constructed and maintained to the following standards [attach design specifications]:
   a) Surface water runoff will be diverted from entering the feed storage structure.[1]
   b) Surface discharge of leachate will be collected before it leaves the feed storage structure.[2]
   c) The top of the feed storage structure floor will be at least 3 vertical feet from groundwater and bedrock.[3]
   d) Any feed storage structure with an area greater than 10,000 sq. ft. will have a subsurface drainage system to collect leachate that may leak through the structure floor. The subsurface drainage system must consist of drainfill material below the surface material, a tile drainage network designed to collect the leachate and deliver it to storage, and a subliner. The tile drainage network must, at a minimum, be installed at the perimeter of the structure only on the downgradient side(s). The sub–liner must, at a minimum, consist of one of the following:
      - Two feet of soil, either in place or installed, having a minimum of 50% fine soil particles (that pass a #200 soil sieve).
      - Two feet of soil, either in place or installed, having a minimum of 30% fine soil particles (that pass a #200 soil sieve) and a minimum PI (plasticity index) of 7.
      - A 40 mil liner of HDPE, EPDM or PVC.
      - A geosynthetic clay liner.
   e) Collected leachate will be stored and disposed of in a manner that prevents discharge to waters of the state.[2]

Nonpoint Pollution Standards

The livestock facility will be designed, constructed and maintained to do all of the following:

1. Divert runoff from contact with *animal lots, waste storage facilities*, paved feed storage areas or manure piles within 300 ft. of a stream or 1,000 ft. of a lake.
2. Avoid having any unconfined manure pile within 300 ft. of a stream or 1,000 ft. of a lake.
3. Prevent any overflow of *waste storage facilities*.
4. Restrict livestock access to waters of the state, as necessary to maintain adequate vegetative cover on banks adjoining the water (this does not apply to properly designed, installed and maintained livestock or farm equipment crossings).

WISCONSIN RONNIE Professional Engineer's Embossed Seal 42226 AUGUSTA WI 8-10-17 LICENSED PROFESSIONAL ENGINEER

Signature of Applicant or Authorized Representative — Date: 8-10-17

Ronnie Williams PE 42226
Print Name of Engineer (include WI License No.) or Certified Practitioner

Signature of Engineer or Practitioner — Date: 8-10-17

Williams Engineering Services, LLC
E14910 Bears Grass Rd
Augusta WI 54722
Name of Firm and Address

[1] Runoff may be diverted by means of earthen diversions, curbs, walls, gutters, waterways or other practices, as appropriate.

[2] Use safe methods to dispose of collected leachate. For example, leachate may be transferred to waste storage and then applied to land at agronomic rates.

[3] A tile system or curtain drain may be used to intercept lateral groundwater seepage, as necessary, to achieve the required distance to groundwater.

Existing Wells

Existing House

Existing Barn

Existing Barn

Existing Feedpad

Existing Transfer Lines

Existing Separation Building

Existing HDPE Lined WSF

Existing Transfer Lines

Existing Building

Existing Cleanout

Existing Transfer Lines

Existing Tank

Existing Barn

Existing Well

Existing Building

Existing Tank

Existing Heifer Building

Existing Calf Hutch Area

Existing Stormwater Pond

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES

PROFESSIONAL ENGINEERING

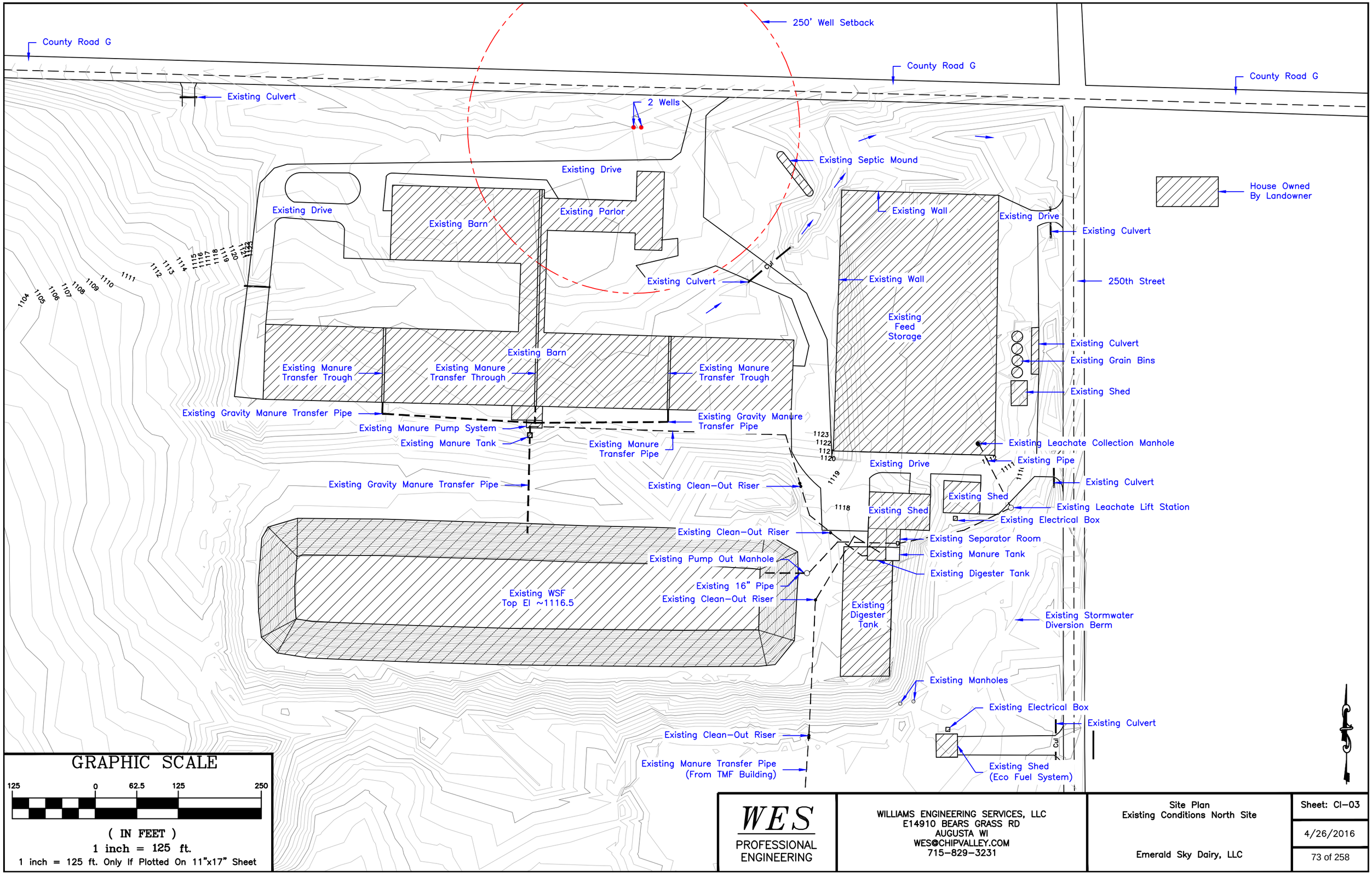
WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Existing Site Conditions

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017



GRAPHIC SCALE

125 0 62.5 125 250

(IN FEET)

1 inch = 125 ft.

1 inch = 125 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

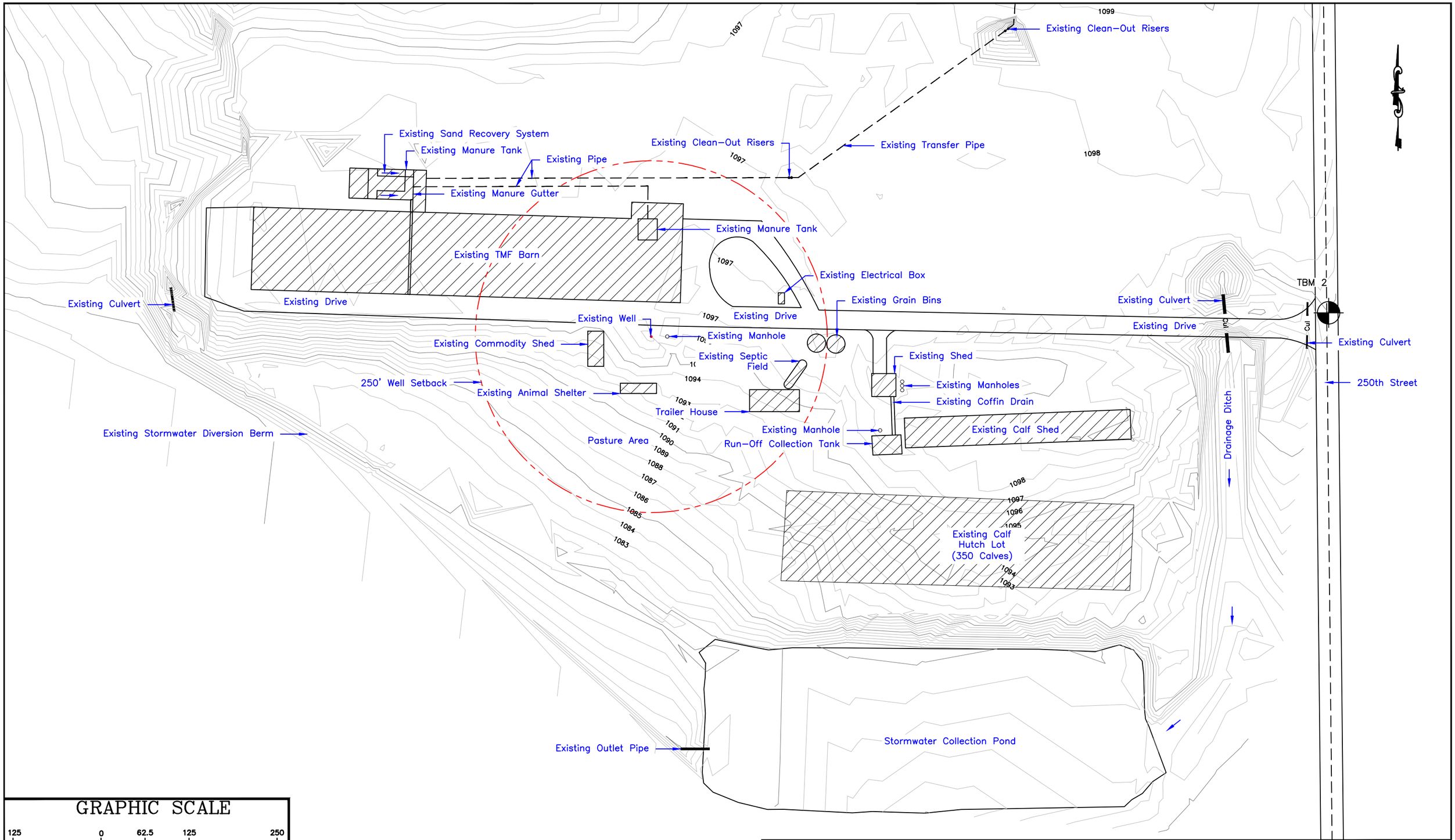
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan
Existing Conditions North Site

Emerald Sky Dairy, LLC

Sheet: CI-03

4/26/2016



GRAPHIC SCALE

125 0 62.5 125 250

(IN FEET)

1 inch = 125 ft.

1 inch = 125 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

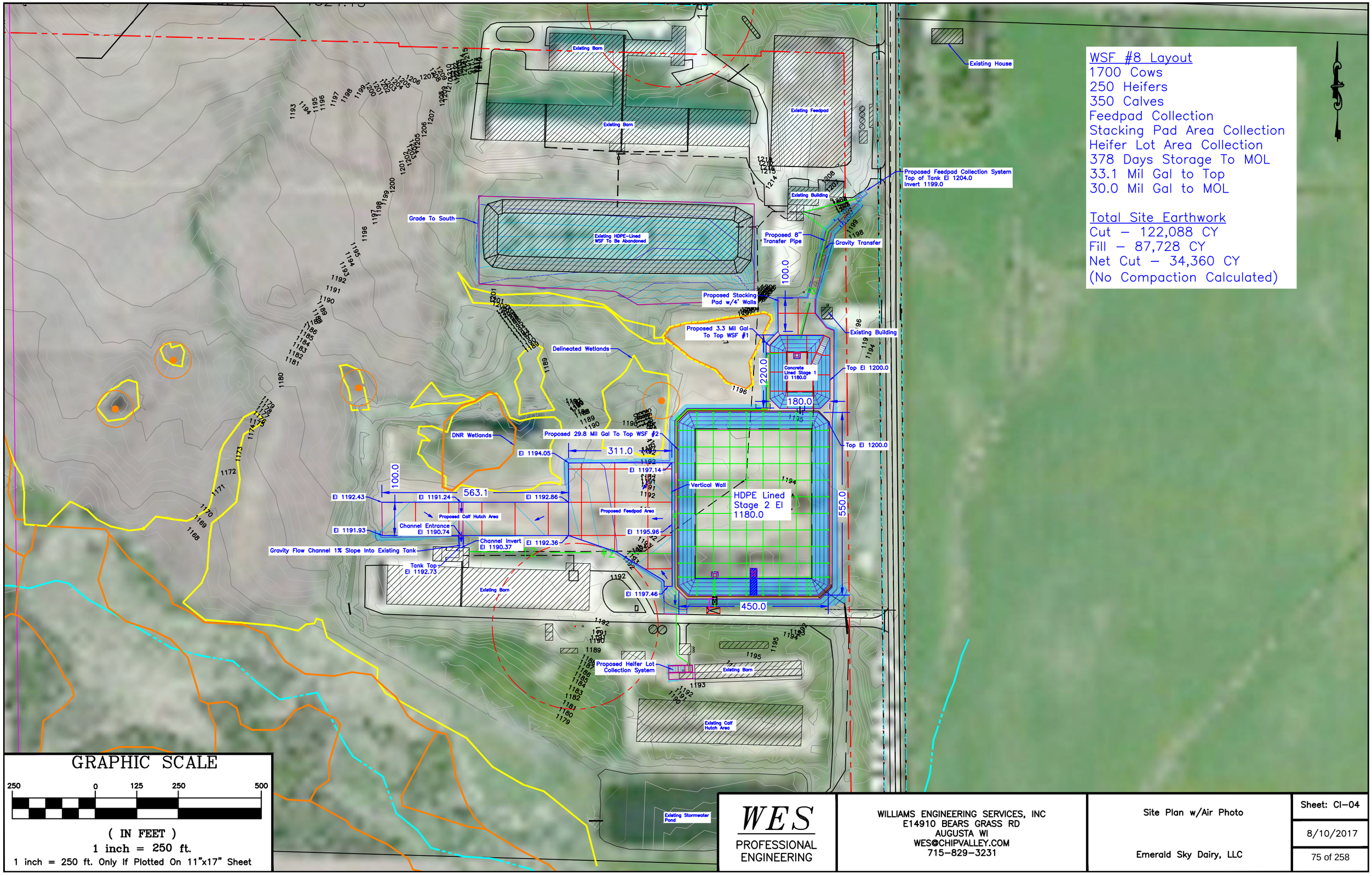
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan
Existing Conditions South Site

Emerald Sky Dairy, LLC

Sheet: CI-04

4/26/2016



WSF #8 Layout
1700 Cows
250 Heifers
350 Calves
Feedpad Collection
Stacking Pad Area Collection
Heifer Lot Area Collection
378 Days Storage To MOL
33.1 Mil Gal to Top
30.0 Mil Gal to MOL

Total Site Earthwork
Cut – 122,088 CY
Fill – 87,728 CY
Net Cut – 34,360 CY
(No Compaction Calculated)

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)
1 inch = 250 ft.
1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

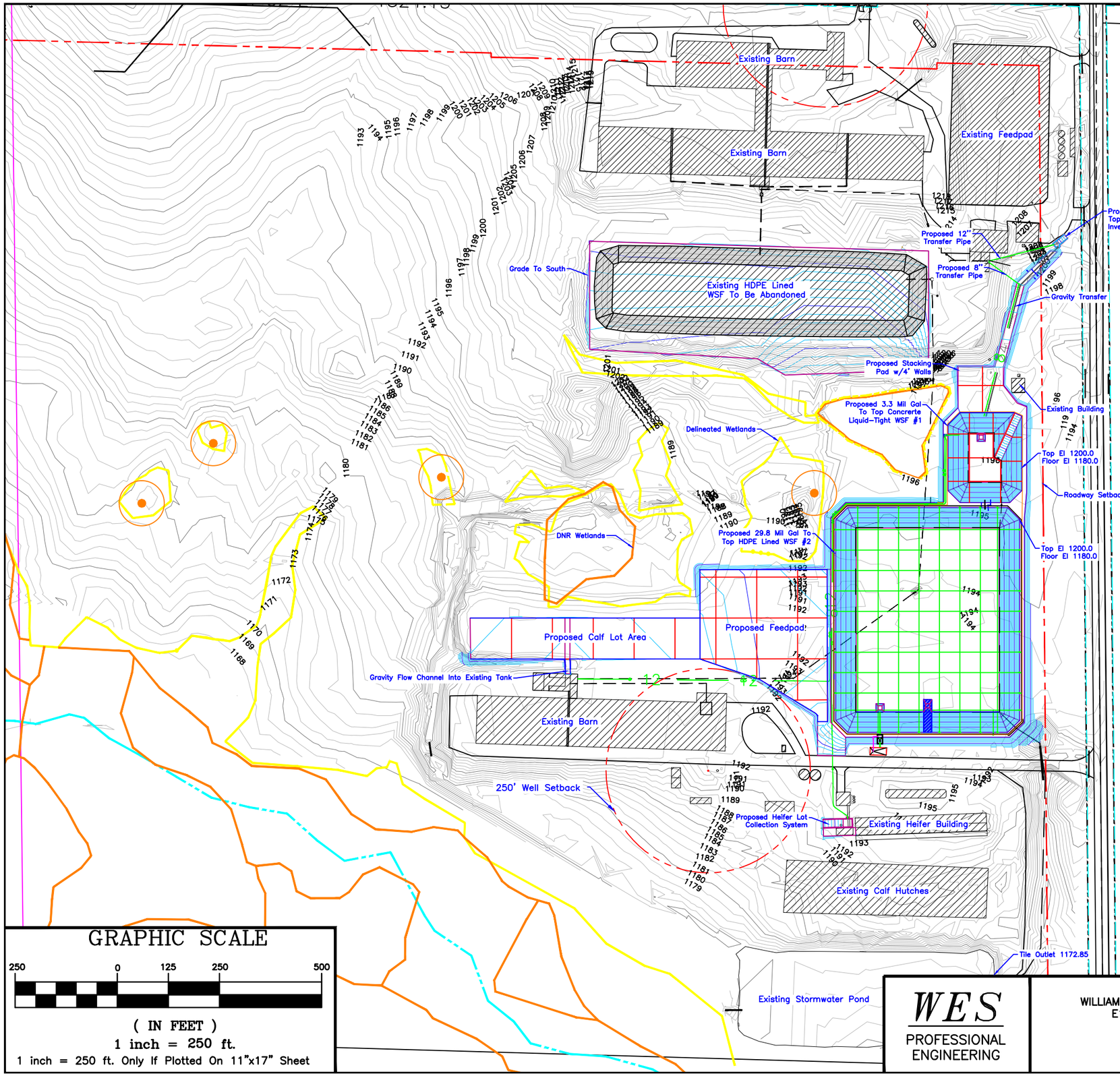
WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan w/Air Photo

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017



WSF Layout
1700 Cows
250 Heifers
350 Calves
Feedpad Collection
Stacking Pad Area Collection
Heifer Lot Area Collection
378 Days Storage To MOL
33.1 Mil Gal to Top
30.0 Mil Gal to MOL

Total Site Earthwork
Cut – 120,400 CY
Fill – 84,838 CY
Net Cut – 35,562 CY
(No Compaction Calculated)

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)
1 inch = 250 ft.
1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan w/o Air Photo

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017

Existing WSF To Be Abandoned
Reshape Waterway
El 1201.00
El 1201.00
Existing Cleanouts
Existing Building
Pinned Waterstop Joint
El 1200.54
Proposed 4' Concrete Wall
Proposed Stacking Pad
End Wall
El 1200.50
El 1200.10
6" Curb
El 1201.00
Roadway Setback
Existing Transfer Line To Be Abandoned
Invert El 1196.68
2' Concrete Safety Wall W/Stage Storage Markers
Start Tile Location Invert El 1177.50
Backflow Prevention Riser
12" Outlet El 1190.00
Invert El 1177.34
Concrete Ramp
Pinned PVC Waterstop
Invert El 1177.19
6" Perimeter Drain Tile Sloped @ 0.25%
Bottom El 1180.00
Top El 1200.00
Bi-Directional Cleanouts
Tile Invert El 1176.99
Tile Invert El 1177.19
6" PVC Outlet Pipe Sloped @ 0.5%
Invert El 1176.72
Perimeter Tile Monitoring Riser Top El 1201.00
Bi-Directional Cleanouts
Concrete Crossover Channel Invert El 1196.00
Top El 1200.00
12" Crossover Pipe Invert El 1196.00
0+00
0+50
50.0'
2.5:1
3:1
6:1
d12
d8
Cul

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Concrete WSF Annotation

Emerald Sky Dairy, LLC

Bi-Directional Cleanouts
Tile Invert El 1176.72
Tile Invert El 1176.22
Concrete Channel Crossover El 1196.00
12" Crossover Pipe El 1196.00
3:1
Top El 1200.00
Bi-Directional Cleanouts
Perimeter Safety Fence
Bi-Directional Cleanouts
Tile Invert El 1175.15
2.5:1
Tile Invert El 1175.5
ADS AdvanEdge Vent Tile Network at 50' OC Spacing
El 1194.05
2' or 4' Wall
El 1197.14
3:1
4' Vertical Wall ~El 1201.00
Existing Transfer Pipe To Be Removed
Pinned Waterstop Joints
Vertical Wall Waterstop Joints No More Than 100' Apart
2.5:1
2.5:1
3:1
2' Wall
El 1192.86
Proposed Feedpad
WSF #2 – 20' Deep 60 Mil HDPE Plastic Lined Pond – Bottom El 1180.00
Proposed Calf Hutch Area
Bi-Directional Cleanouts
Bi-Directional Cleanouts
6" Perimeter Drain Tile Sloped @ 0.25%
6" Perimeter Drain Tile Sloped @ 0.1%
2' Wall
El 1192.36
250' Well Setback
Existing Transfer Lines
Anchor Trench Location
Directional Cleanout
Bi-Directional Cleanouts
12" Transfer Line Invert El 1200.00
Sump El 1178.00
Typical Agitation Pad w/18" Curbs
Reception Pit
2' or 4' Wall
Tile Invert El 1174.70
Tile Invert El 1174.37
0.5% Slope
El 1197.24
Tile Invert El 1174.08
Perimeter Tile Monitoring Riser Top El 1201.00
2.5:1
Pump Out Top El 1200.50
Tile Invert El 1173.58
Existing Barn
9:1 Ramp
Core Trench
Load Out Pad Floor 1193.25
3:1
6" PVC Perimeter Tile Outlet Pipe Sloped @ 0.1% To Daylight Outlet El At Existing Ground ~ 1172.85
Electrical Transformer
Existing Driveway
Existing Well

GRAPHIC SCALE

70 0 35 70 140

(IN FEET)

1 inch = 70 ft.

1 inch = 70 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

HDPE Pond and Feedpad Annotation

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017

2 or 4' Wall
El 1194.23
232.3
El 1191.24
562.6
318.3
Vertical Wall Waterstop Joints Shall Not Be More Than 100' Apart
4' Wall
El 1192.86
12.0
12.0
0.5% Slope
Concrete Lined Area
Concrete Lined Area
Proposed Calf Hutch Area
Proposed Feedpad
0+00
0+50
100.0
Pinned Waterstop Joints
100.0
El 1191.93
1% Slope
El 1190.74
3:1
2' or 4' Wall
2' Wall
36.5
El 1190.38
2' or 4' Wall
El 1192.36
2' or 4' Wall
12" PE DR 17 Transfer Pipe
To Be Removed and Replaced
12
Manure Pumping Room
Existing Transfer Line To Remain
Existing Transfer Lines
Directional Cleanout
250' Well Setback
Existing Barn

GRAPHIC SCALE

40 0 20 40 80

(IN FEET)

1 inch = 40 ft.

1 inch = 40 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Calf Lot Area – Anno and Dim

Emerald Sky Dairy, LLC

Emergency Response Plan

Farm Name: Emerald Sky Dairy, LLC

Owner/Operator: Emerald Sky Dairy, LLC Phone: 402-996-0848 Cell: _____

Owner/Operator: TJ Tuls Phone: 402-526-2385 Cell: 402-366-0363

Farm Address: 2487 County Road G, Emerald, WI 54013

Farm Location: T 30 N, R 16 ◯E ◯W Section 22 County: St. Croix

Driving Directions or Emergency Coordinates: Take Hwy 63 North From Baldwin, WI, Turn Right Onto County Road O, Emerald Sky Will Be On the Right After 240th Street and Before 250th Street

In Case of Injury, Fire, or Rescue Emergency, Immediately Implement the Following:

1. Assess the condition of the victim, extent of the emergency (fire, rescue) and call for help.
2. Stabilize the victim, use on-site rescue equipment, evacuate buildings, or begin fire suppression as necessary.
3. Brief emergency responders upon arrival on current status of situation.

In Case of a Spill, Leak, or Failure at the Storage Facility, During Transport, or Land Application, Immediately Implement the Following:

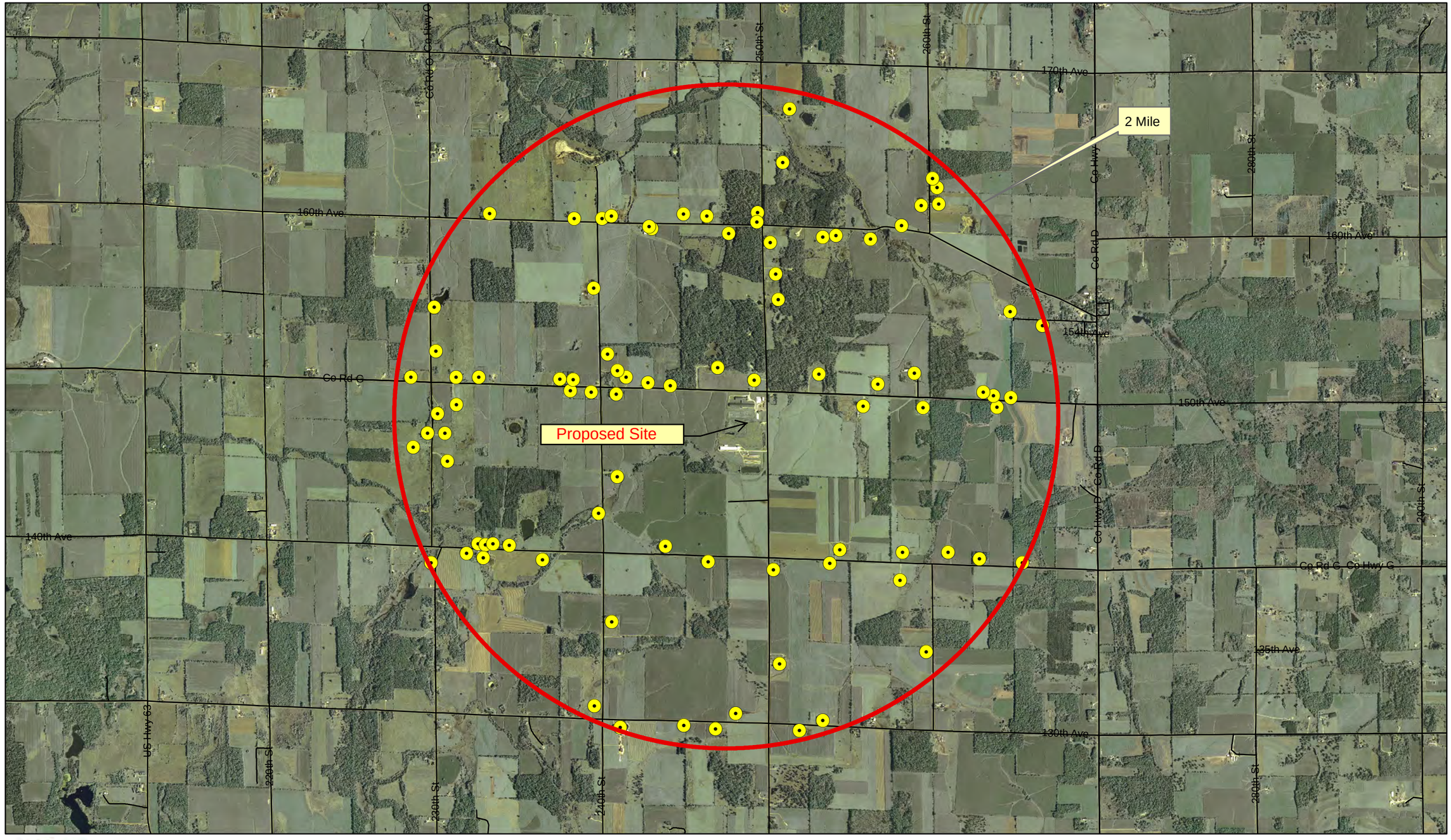
1. Stop the source of the leak or spill. For example:
   - Turn off all pumps/valves and clamp hoses or park tractor on hoses to stop the flow of manure.
2. Assess the situation and make appropriate calls for people, equipment, and materials. See contacts below.
   - Notify DNR spill hotline: 1-800-943-0003 (Spill reporting is mandatory by state law.)
   - Call sheriff's office if spilled on public roads or its right-of-ways for traffic control.
   - Clear the road and roadside of spilled material immediately.
3. Contain the spill and prevent spillage from entering surface waters, tile intakes, or waterways.
   - Use a skid loader or tractor with a blade to build dikes to contain or divert the spill or leak.
   - Insert sleeves around tile intakes (or plug/cap intakes) and block down slope culverts.
   - Use tillage implements to work up the ground ahead of the spill or use absorptive materials.
4. Begin cleanup.
   - Use pumps to recover liquids.
   - Land apply on approved cropland at appropriate rates.
5. Document your actions.

Emergency Contacts	Contact Person (or Company)	Phone Number
Fire/Rescue	Glenwood Fire Department	911 or 715-265-7883
County Sheriff	St. Croix County Sheriff	911 or 715-381-4339
Farm Emergency Coordinator	Todd Tuls/TJ Tuls	402-366-0363/402-996-0848
DNR Hazardous Spill Line		1-800-943-0003
DNR Permit Contact/Warden	Robert Rohland	715-284-1429
Veterinarian	TBD	
Equipment/Supplies	**Contact Person (or Company)**	**Phone Number**
On-Farm Equipment Operator	TBD	
Excavation Contractor	TBD	
Manure Hauler	TBD	
Septic Tank Pumping Truck	TBD	
Mortality Disposal Contractor	TBD	
Local Government Contacts	**Contact Person**	**Phone Number**
Town Chairman	Henry Hurtgen	715-977-0008
LCD County Conservationist	Steve Olson	715-531-1908
NRCS District Conservationist	Jason Barrick	715-684-2874

Be prepared to provide the following information:

- Your name and contact information
- Farm address, location and other pertinent identification information.
- Nature of emergency (employee injury, fire, discharge of manure or hazardous materials).
- Emergency equipment and personnel that are needed.
- Potential for manure or hazardous materials to reach surface waters or major field drains.
- Current status of containment efforts.
- Location of hazardous/flammable materials, fire suppression equipment, emergency cut off switches or valves.

Emerald Sky Dairy, LLC
2 Mile Residence Map



WES

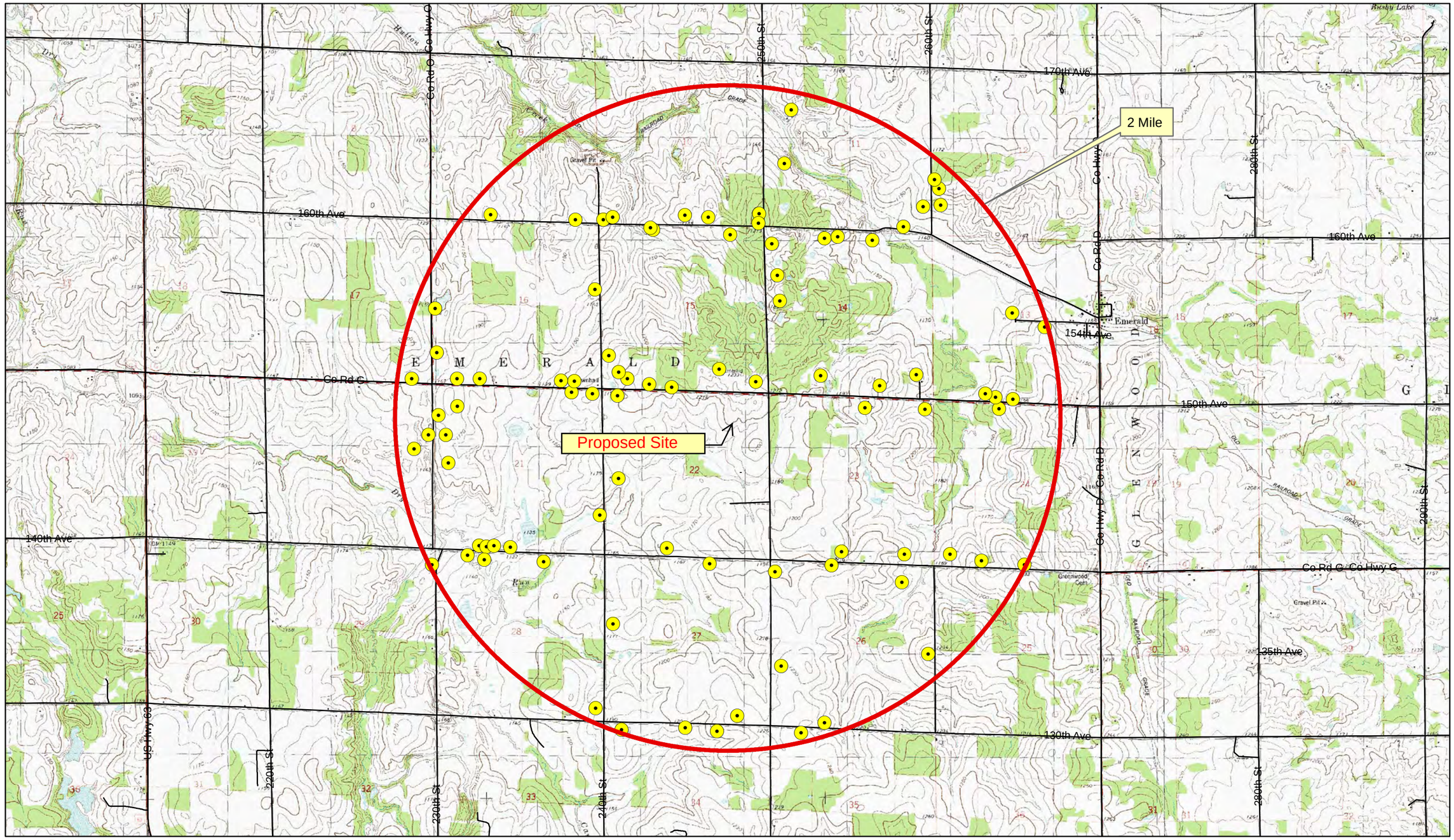
Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
Ronnie Williams, PE WI #35284
(715) 829-3231

0 0.5 1 2 3 Miles

N

Roads

Emerald Sky Dairy, LLC
2 Mile Residence Contour Map



WES

Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
Ronnie Williams, PE WI #35284
(715) 829-3231

Emerald Sky Dairy, LLC Site Map

Legend

- Impaired Rivers and Streams
- Impaired Lakes

TMDL Category Lines

- Other or Multiple Factors
- Contaminated Sediment Dominated
- Atmospheric Deposition Dominated
- Physical or Habitat Dominated
- Nonpoint Source Dominated
- Point and Nonpoint Source Blend
- Point Source
- Proposed for 303d listing

TMDL Category Areas

- Other or Multiple Factors
- Contaminated Sediment Dominated
- Atmospheric Deposition Dominated
- Physical or Habitat Dominated
- Nonpoint Source Dominated
- Point and Nonpoint Source Blend
- Point Source
- Proposed for 303d listing

Impaired Waters Status Rivers

- Other or Multiple TMDLs
- Proposed for List
- 303d Listed
- Addition
- TMDL Development
- TMDL Approved
- TMDL Implementation
- Deletion
- Delist
- Water Delisted

0.5 0 0.25 0.5 Miles

NAD_1983_HARN_Wisconsin_TM

1: 15,840

Notes

Employee Training Plan

EMERALD SKY DAIRY, LLC
TOWN OF EMERALD
ST. CROIX COUNTY, WISCONSIN

Prepared by:
Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
715-829-3231

August, 2017

Table of Contents

Introduction

Williams Engineering Services, LLC (WES) has developed this Employee Training Program to ensure employees are trained in the proper procedures, accident response and safety precautions of the daily operations of the Emerald Sky Dairy facility. The employee training program will outline daily and seasonal waste handling, odor management, manure management, nutrient management, clean water versus contaminated water runoff management, employee safety and incident/accident response. This employee training program was designed in accordance with item number 12 of the WDATCP Siting Law Application.

Overview

Emerald Sky Dairy, LLC will have approximately 50 full time employees working on the dairy. All employees must be trained upon being hired and a refresher training twice a year. Training will be conducted by the managers as well as any experts that the managers hire to provide assistance. Managers shall keep attendance records on all training sessions as well as the training outline.

Employee Training Sessions shall include the following:

Waste Handling (Manure and Wastewater)

On an ongoing basis, managers of Emerald Sky Dairy will develop a list of operating procedures and safety protocols that employees must follow at all times.

Training Topics:

-Operating procedures and safety protocols while loading, pumping and handling manure
-Emergency response protocol and contact information during an accident or spill
-Safety precautions

Odor Management

Emerald Sky Dairy, LLC will attempt to eliminate as much odor from the dairy as possible. The HDPE lined waste storage facilities will have an impermeable cover to reduce odors. The dairy's feed will be stored in concrete bunkers and covered in plastic. The plastic will reduce feed spoiling which in turn will reduce odor. A custom manure applicator will haul and apply manure according to Emerald Sky Dairy's Nutrient Management Plan (NMP). An odor management plan was designed in accordance with item number 14 of the WDATCP Siting Law Application.

Training Topics:

-Understanding and implementing the odor management plan
-Sources and causes of odor from the dairy
-Preventing odor
-Procedures for maintenance of covers
-Understanding how to complete an odor complaint worksheet
-Safety precautions

Nutrient Management

Tim Popple of Popple Consulting will be completing a (Nutrient Management Plan) for Emerald Sky Dairy in accordance with USDA-NRCS Conservation Practice Standard 590. The NMP will be updated on an annual basis.

Training Topics:

-Collecting field soil and manure samples
-Handling and recording sample data
-Recording and reviewing crop rotations and crop yields
-Completing and reviewing manure field spreading logs
-Completing and reviewing waste storage facilities inspection logs
-Reviewing soil test results
-Safety precautions

Runoff Management

A secondary containment berm and diversion berm will be constructed around the facility and site to prevent any storm water run-off as well as contain any catastrophic event. A number of culverts and waterways shall be installed to allow for proper runoff water flow from any precipitation event and prevent run-off or erosion problems on surrounding properties or roadway ditches.

The possibility of sediment build up and blockage of culvert pipes and drainage ways may happen over time. Proper training of employees is required to ensure proper techniques are used to prevent and remove any issues. Runoff management training shall be provided on the following topics:

-Maintaining areas around the facility mowed and trimmed to an acceptable standard
-Patching and reseeding grassy areas as needed
-Maintaining culverts and the secondary containment berm area
-Maintaining waterways and any diversion berms throughout the site

Employee Safety

Employee safety is to be implemented when operating farm equipment, general farm maintenance, animal handling and the handling of hazardous materials.

Employee safety training shall be provided for the following topics:

-Proper techniques for using farm related equipment such as skid steers, tractors, all pumps and any component related to the transfer of waste
-Proper techniques for applying, removing and disposing of bunker silo plastic and tires from the feed piles
-Proper handling and care of all animals and animal types located on site
-Knowledge of the location and contact information for emergency contacts that may be needed at any point for a specified emergency situation

Accident Response

Employees shall be trained in the following areas:

-Emergency response protocol and contact information for each type of potential emergency that could arise on site
-Proper reporting and record keeping requirements for each type of potential emergency that could arise on site as well as the knowledge of the Emergency Action Plan – Incident Report sheet

WISCONSIN
DEPT. OF NATURAL RESOURCES

WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM

Emerald Dairy LLC

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to manage and utilize manure from a livestock facility located at N1/2 NEQ Sec 22 T30N R16W, St. Croix County to

a wetland tributary to Dry Run Creek, and to groundwater and to the Lower Willow River Watershed of The St. Croix River Basin

in accordance with the effluent limitations, monitoring requirements and other conditions setforth in this permit.

The permittee shall not discharge after the date of expiration. If the permittee wishes to continue to discharge after this expiration date an application shall be filed for reissuance of this permit, according to Chapter NR 200, Wis. Adm. Code, at least 180 days prior to the expiration date given below.

State of Wisconsin Department of Natural Resources
For the Secretary

By _____
Robert Rohland
Wastewater Specialist

7/1/2015
Date Permit Signed/Issued

PERMIT TERM: EFFECTIVE DATE – July 01, 2015 **EXPIRATION DATE – June 30, 2020**

*Only Permit Cover Shown

Chapter ATCP 51
Appendix A

EMERALD SKY DAIRY, LLC
TOWN OF EMERALD
ST. CROIX COUNTY, WISCONSIN

Prepared by:
Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
715-829-3231

August, 2017

Site Drawings

Waste Storage Facility, Waste Storage Facility Abandonment, Calf Hutch Runoff Collection Pad, Calf Shed Runoff Collection System, Feed Pad Runoff Collection System, Feed Pad & Waste Transfer System

Existing Wells

Existing House

Existing Barn

Existing Barn

Existing Feedpad

Existing Transfer Lines

Existing Separation Building

Existing HDPE Lined WSF

Existing Transfer Lines

Existing Building

Existing Cleanout

Existing Transfer Lines

Existing Tank

Existing Barn

Existing Well

Existing Building

Existing Tank

Existing Heifer Building

Existing Calf Hutch Area

Existing Stormwater Pond

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Existing Site Conditions

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017

6712
1213.18
tbm53

6009
1224.85
tbm50

6004
1220.20
tbm2

6006
1220.24
tbm3

6003
1211.23
tbm1

6010
1193.91
tbm51

6586
1192.60
tbm52

Existing Barn

Existing Barn

Existing Feedpad

Existing HDPE Lined
WSF To Be Abandoned

Proposed Calf Lot Area

Proposed Feedpad

12

12

Existing Barn

250' Well Setback

Existing Heifer Building

Existing Calf Hutches

Existing Stormwater Pond

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL
ENGINEERING

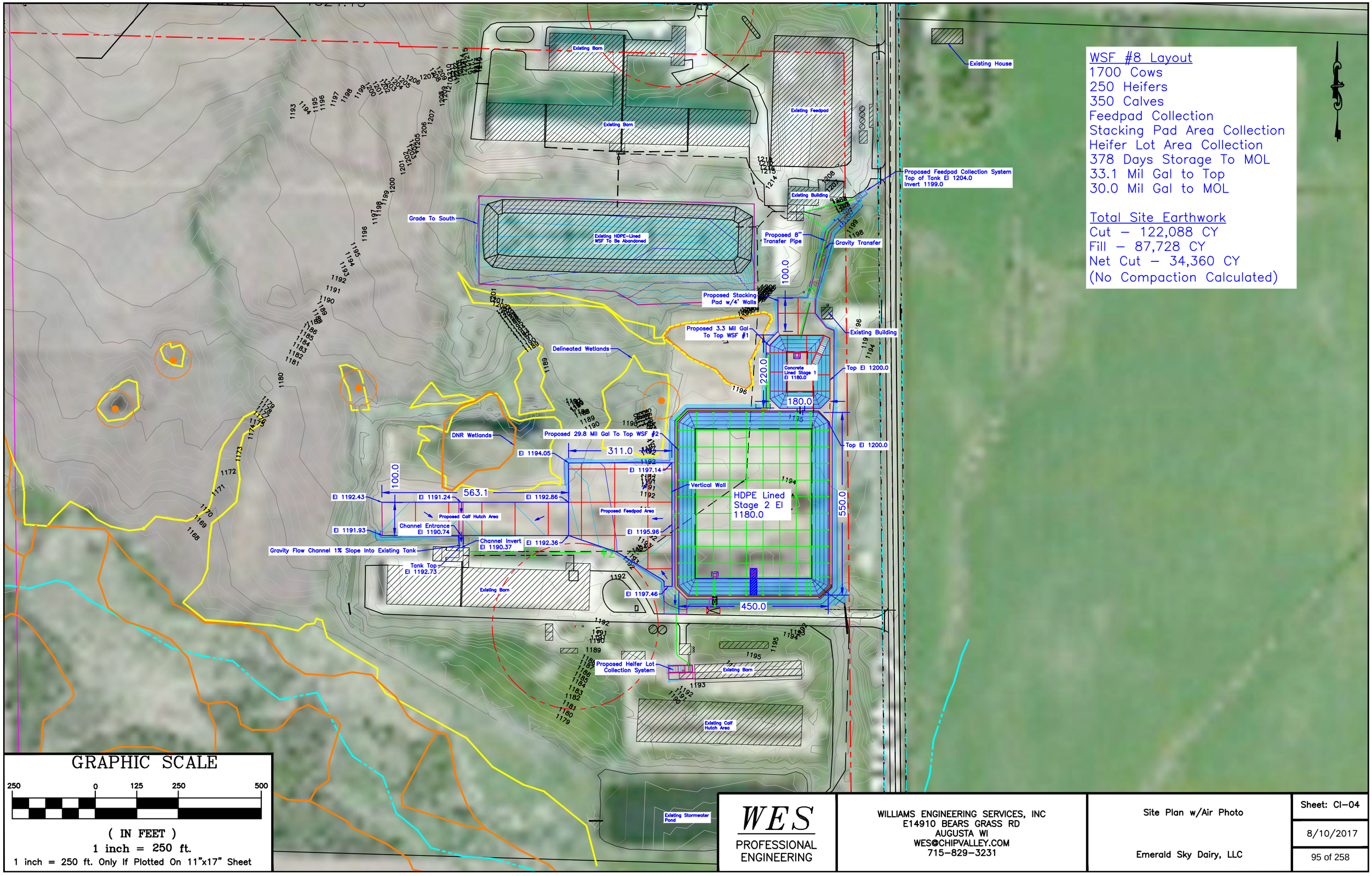
WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Benchmark Location Map

Emerald Sky Dairy, LLC

Sheet: CI-04

8/11/2017



WSF #8 Layout
1700 Cows
250 Heifers
350 Calves
Feedpad Collection
Stacking Pad Area Collection
Heifer Lot Area Collection
378 Days Storage To MOL
33.1 Mil Gal to Top
30.0 Mil Gal to MOL

Total Site Earthwork
Cut – 122,088 CY
Fill – 87,728 CY
Net Cut – 34,360 CY
(No Compaction Calculated)

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)
1 inch = 250 ft.
1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

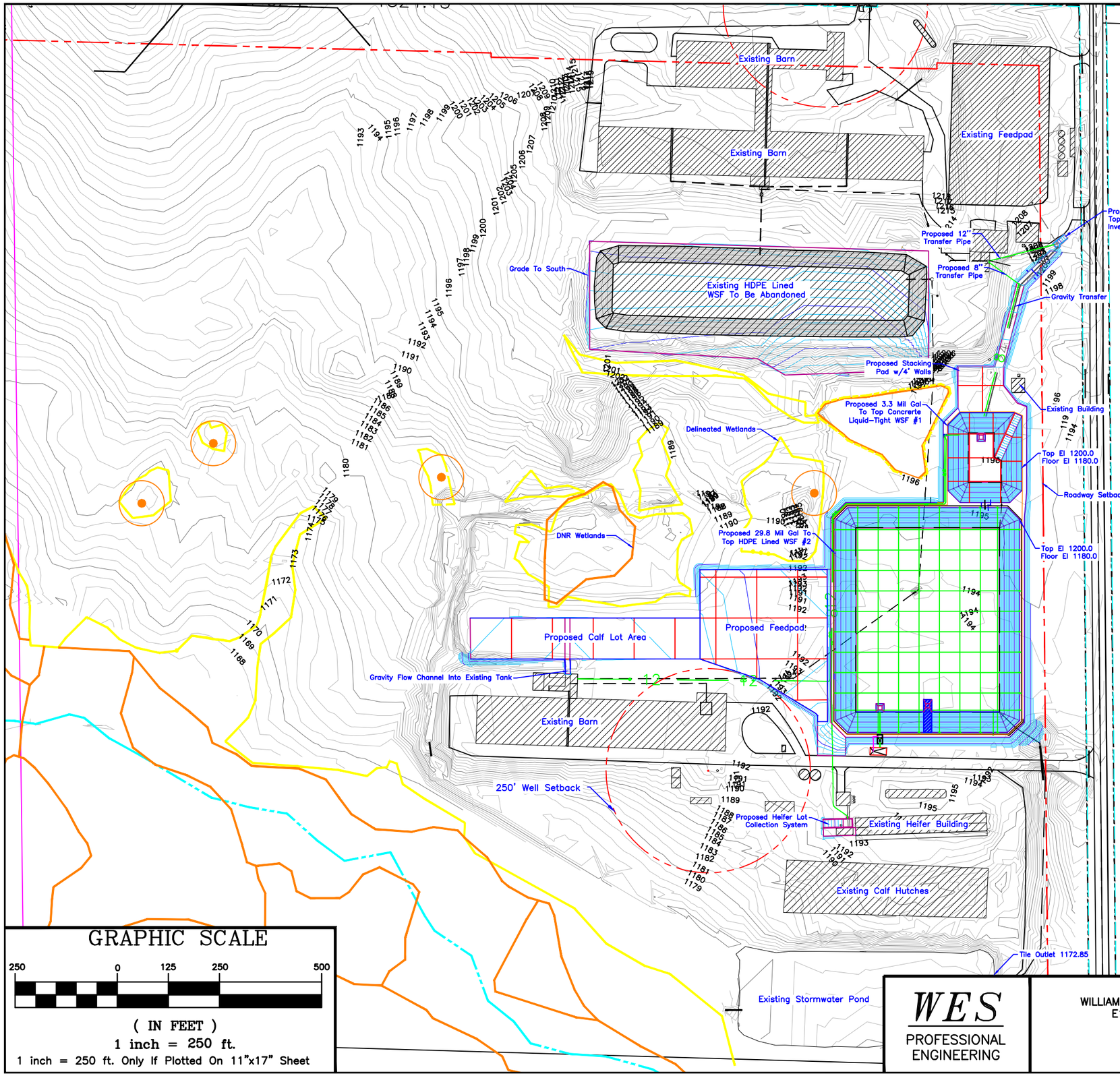
WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan w/Air Photo

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017



WSF Layout
1700 Cows
250 Heifers
350 Calves
Feedpad Collection
Stacking Pad Area Collection
Heifer Lot Area Collection
378 Days Storage To MOL
33.1 Mil Gal to Top
30.0 Mil Gal to MOL

Total Site Earthwork
Cut – 120,400 CY
Fill – 84,838 CY
Net Cut – 35,562 CY
(No Compaction Calculated)

GRAPHIC SCALE
250 0 125 250 500
(IN FEET)
1 inch = 250 ft.
1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan w/o Air Photo

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017

Bi-Directional Cleanouts
Tile Invert El 1176.72
Tile Invert El 1176.22
Concrete Channel Crossover El 1196.00
12" Crossover Pipe El 1196.00
3:1
Top El 1200.00
Bi-Directional Cleanouts
Perimeter Safety Fence
Bi-Directional Cleanouts
Tile Invert El 1175.15
2.5:1
Tile Invert El 1175.5
ADS AdvanEdge Vent Tile Network at 50' OC Spacing
El 1194.05
2' or 4' Wall
El 1197.14
3:1
4' Vertical Wall ~El 1201.00
Existing Transfer Pipe To Be Removed
Pinned Waterstop Joints
Vertical Wall Waterstop Joints No More Than 100' Apart
2.5:1
2.5:1
3:1
2' Wall
El 1192.86
Proposed Feedpad
WSF #2 – 20' Deep 60 Mil HDPE Plastic Lined Pond – Bottom El 1180.00
Proposed Calf Hutch Area
Bi-Directional Cleanouts
Bi-Directional Cleanouts
6" Perimeter Drain Tile Sloped @ 0.1%
6" Perimeter Drain Tile Sloped @ 0.25%
2' Wall
El 1192.36
250' Well Setback
Existing Transfer Lines
Directional Cleanout
Bi-Directional Cleanouts
12" Transfer Line Invert El 1200.00
Anchor Trench Location
Sump El 1178.00
Typical Agitation Pad w/18" Curbs
Reception Pit
2' or 4' Wall
Tile Invert El 1174.70
Tile Invert El 1174.37
0.5% Slope
El 1197.24
2.5:1
Tile Invert El 1174.08
Perimeter Tile Monitoring Riser Top El 1201.00
Pump Out Top El 1200.50
Tile Invert El 1173.58
Existing Barn
9:1 Ramp
Core Trench
Load Out Pad Floor 1193.25
3:1
6" PVC Perimeter Tile Outlet Pipe Sloped @ 0.1% To Daylight Outlet El At Existing Ground ~ 1172.85
Electrical Transformer
Existing Driveway
Existing Well

GRAPHIC SCALE

70 0 35 70 140

(IN FEET)

1 inch = 70 ft.

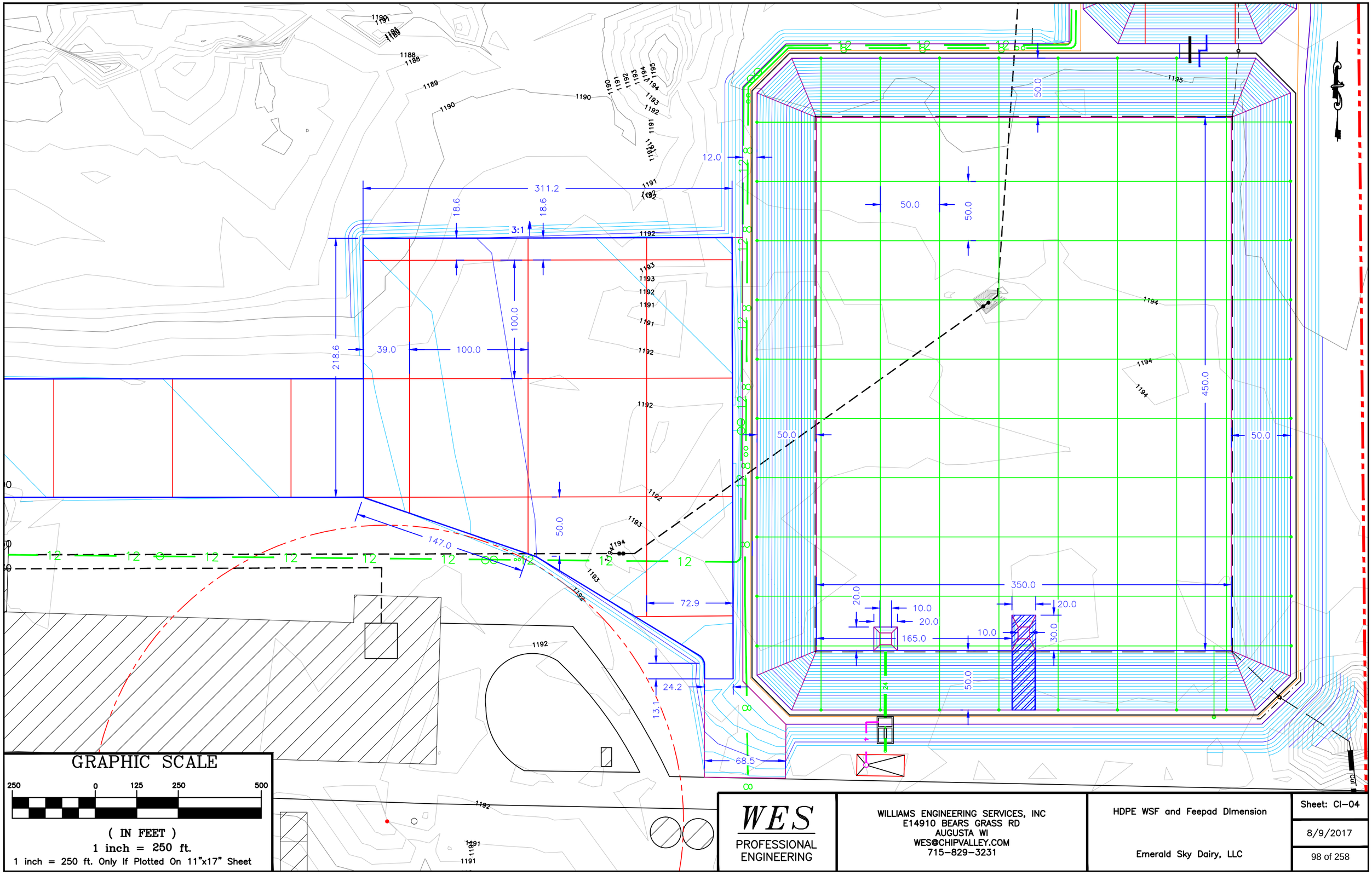
1 inch = 70 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

HDPE Pond and Feedpad Annotation

Emerald Sky Dairy, LLC



WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

HDPE WSF and Feepad Dimension

Emerald Sky Dairy, LLC

Sheet: CI-04

8/9/2017

Existing WSF To Be Abandoned
Existing Cleanouts
Proposed 4' Concrete Wall
Existing Transfer Line To Be Abandoned
Backflow Prevention Riser
Bi-Directional Cleanouts
Bi-Directional Cleanouts
Reshape Waterway
El 1201.00
El 1201.00
Existing Building
Pinned Waterstop Joint
El 1200.54
Proposed Stacking Pad
End Wall
El 1200.50
El 1201.00
Roadway Setback
El 1200.10
6" Curb
Invert El 1196.68
2.5:1
2' Concrete Safety Wall W/Stage Storage Markers
Start Tile Location Invert El 1177.50
12" Outlet El 1190.00
Invert El 1177.34
Concrete Ramp
6:1
2.5:1
3:1
3:1
Pinned PVC Waterstop
Invert El 1177.19
Top El 1200.00
6" Perimeter Drain Tile Sloped @ 0.25%
Bottom El 1180.00
2.5:1
Tile Invert El 1176.99
Tile Invert El 1177.19
2.5:1
6" PVC Outlet Pipe Sloped @ 0.5%
Invert El 1176.72
Perimeter Tile Monitoring Riser Top El 1201.00
Concrete Crossover Channel Invert El 1196.00
Top El 1200.00
12" Crossover Pipe Invert El 1196.00
0+00
0+50
50.0
Cul
Cul
Cul
Cul

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

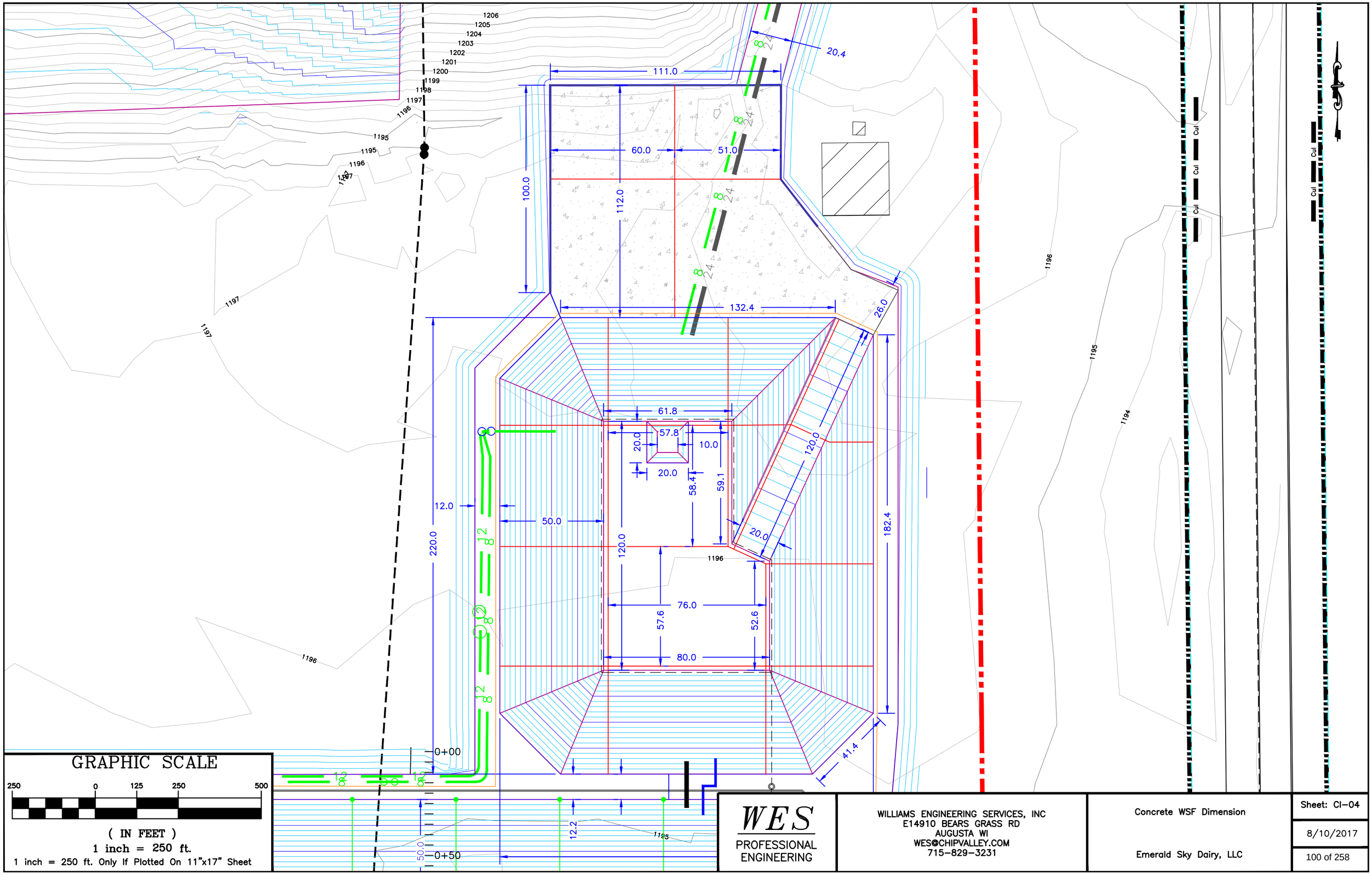
WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Concrete WSF Annotation

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017



GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Concrete WSF Dimension

Emerald Sky Dairy, LLC

2 or 4' Wall
El 1194.23
232.3
El 1191.24
562.6
318.3
Vertical Wall Waterstop Joints Shall Not Be More Than 100' Apart
4' Wall
El 1192.86
12.0
12.0
0.5% Slope
Concrete Lined Area
Concrete Lined Area
Proposed Calf Hutch Area
Proposed Feedpad
100.0
Pinned Waterstop Joints
100.0
El 1191.93
1% Slope
El 1190.74
3:1
2' or 4' Wall
2' Wall
36.5
El 1190.38
2' or 4' Wall
El 1192.36
2' or 4' Wall
12" PE DR 17 Transfer Pipe
To Be Removed and Replaced
12
Manure Pumping Room
Existing Transfer Line To Remain
Existing Transfer Lines
Directional Cleanout
250' Well Setback
Existing Barn

GRAPHIC SCALE

40 0 20 40 80

(IN FEET)

1 inch = 40 ft.

1 inch = 40 ft. Only If Plotted On 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Calf Lot Area – Anno and Dim

Emerald Sky Dairy, LLC

Delineated Wetlands

Typical Clay Liner Borrow Area

TP1069 TP1068 TP1063 TP1062 TP1057 TP1053 TP1048 TP1042 TP1054

TP1070 TP1064 TP1061 TP1058 TP1052 TP1049 TP1046 TP1043 TP1055

TP1066 TP1065 TP1060 TP1051 TP1050 TP1045 TP1044

TP1223

TP1225 TP1224 TP1222 TP1221 TP1220

TP1233 TP1232 TP1231

24

TP1026 TP1025 TP1024

24

TP2 TP1021 TP1020 TP1019

TP1015 TP1017 TP1230 TP3

TP1016 TP1018

TP1014 TP1013 TP1012 TP1011 TP1010 TP1229

TP1005 TP1007 TP1008 TP1009 TP1006

TP1004 TP1003 TP1 TP1227 TP1002 TP1228 TP1001

TP1226

TP1219

TP1217 TP1218

GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

1 inch = 300 ft. Only If Plotted On 11"x17" Sheet

WES PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Site Plan

Site Test Pit Locations
Clay Liner Borrow Area

Emerald Sky Dairy, LLC

8/7/2017

Existing HDPE Lined WSF Abandonment

Separation Building 8" Transfer Pipe Cross Section #1

Separation Building 12" Transfer Pipe Cross Section #1

Concrete WSF and Stacking Pad Cross Section #1

Feedpad Collection System Cross Section #1

Concrete WSF Cross Section #2

HDPE Lined WSF Cross Section #1

HDPE Lined WSF Cross Section #2

Feedpad Cross Section #1

Calf Lot Cross Section #1

Calf Lot Into Existing Tank Cross Section #1

Existing Tank to Concrete WSF Cross Section

Heifer Lot Collection Tank Cross Section #1

Heifer Lot Collection Transfer Cross Section

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

1 inch = 250 ft.

1 inch = 250 ft. Only If Plotted On 11"x17" Sheet

WES PROFESSIONAL ENGINEERING

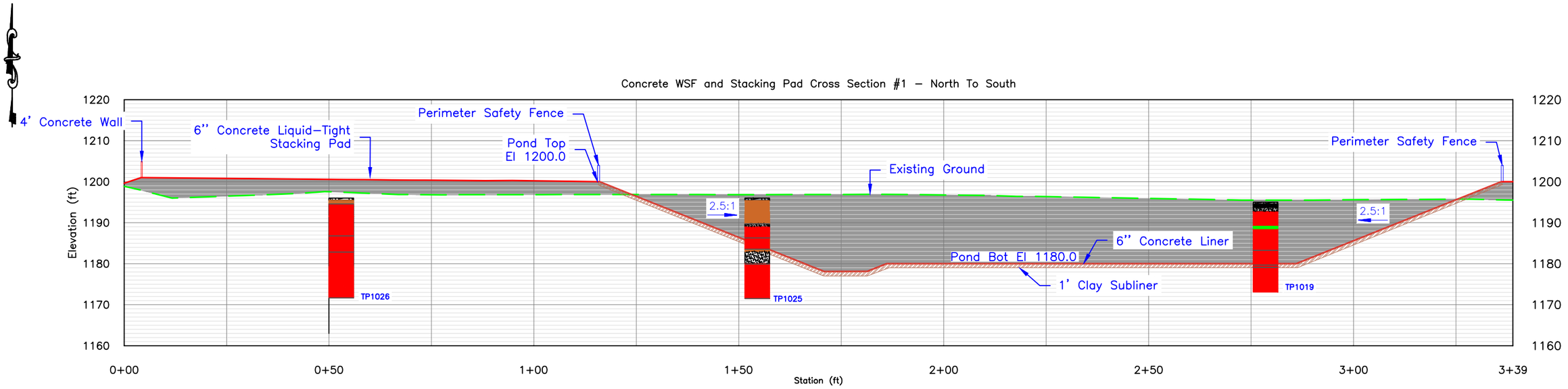
WILLIAMS ENGINEERING SERVICES, INC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

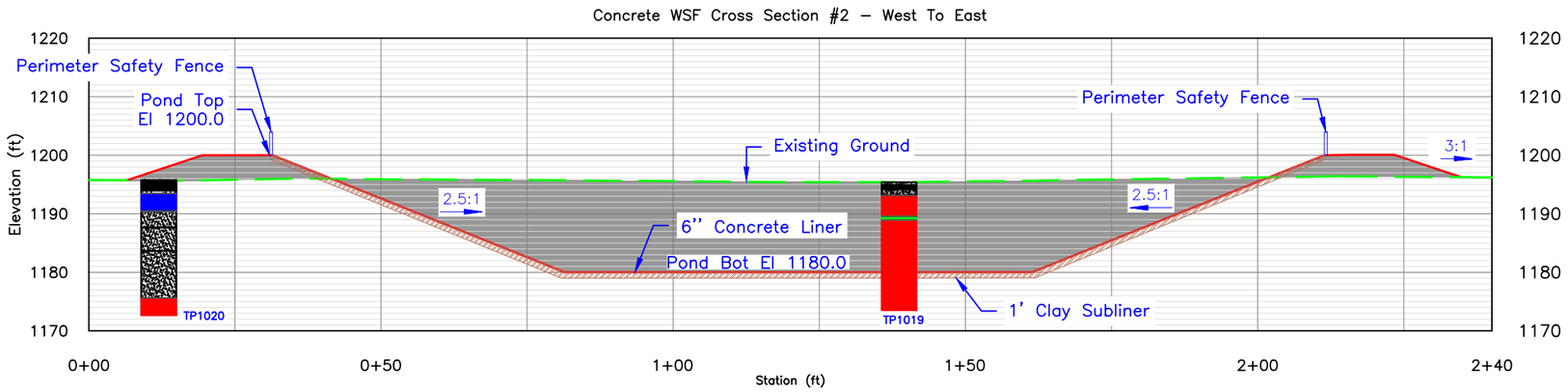
Cross Sections Plan View

Emerald Sky Dairy, LLC

Sheet: CI-04

8/10/2017





Topsoil
Disturbed
ML
CL
GP
SM
SC
SP

GRAPHIC SCALE

25 0 12.5 25 50

(IN FEET)

1 inch = 25 ft.

1 inch = 25 ft. Only If Plotted On 11"x17" Sheet

1 inch = 25 ft Only if Plotted on 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

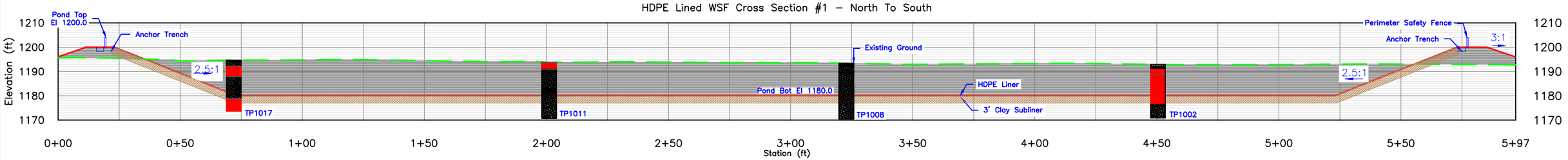
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

Concrete Lined WSF Cross Sections

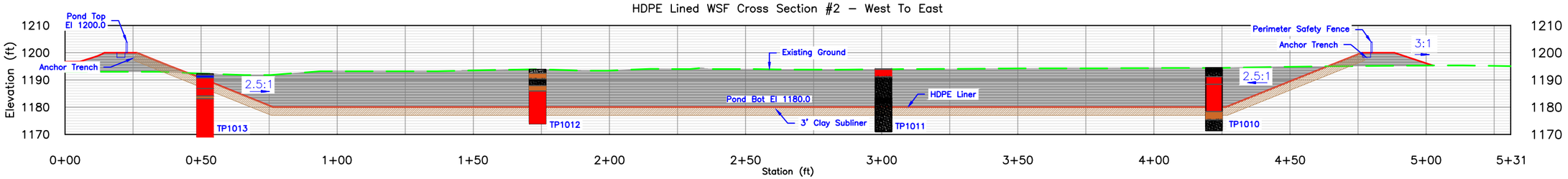
Emerald Sky Dairy, LLC

8/10/2017

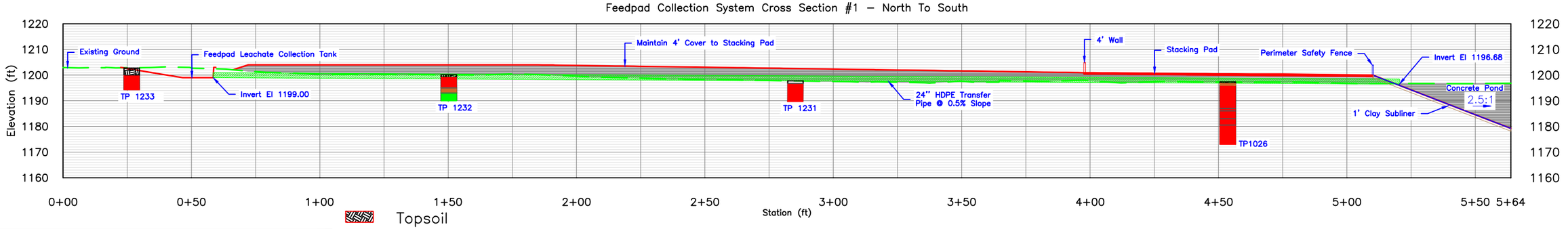
HDPE Lined WSF Cross Section #1 – North To South



HDPE Lined WSF Cross Section #2 – West To East



Feedpad Collection System Cross Section #1 – North To South



GRAPHIC SCALE

40 0 40 40 80

(IN FEET)

1 inch = 40 ft.

1 inch = 40 ft. Only If Plotted On 11"x17" Sheet

- Topsoil
- Disturbed
- ML
- CL
- GP
- SM
- SC
- SP

1 inch = 40 ft Only if Plotted on 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

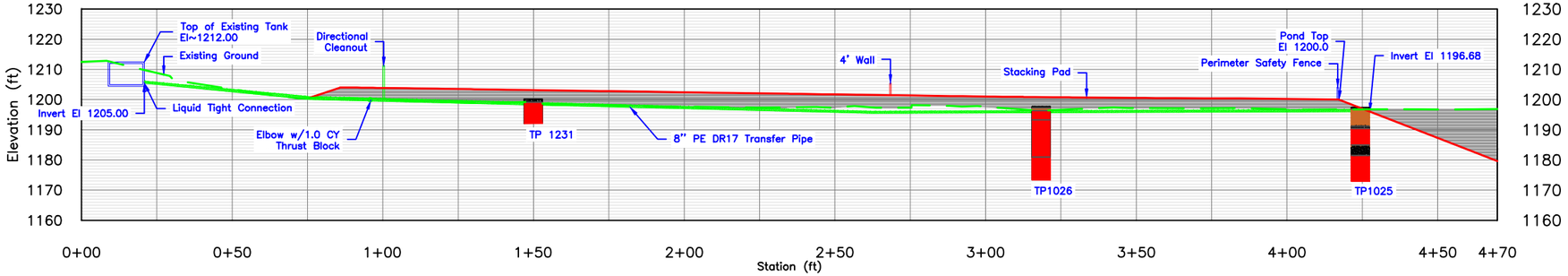
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

HDPE Lined Cross Sections
Feedpad Collection System Cross Section

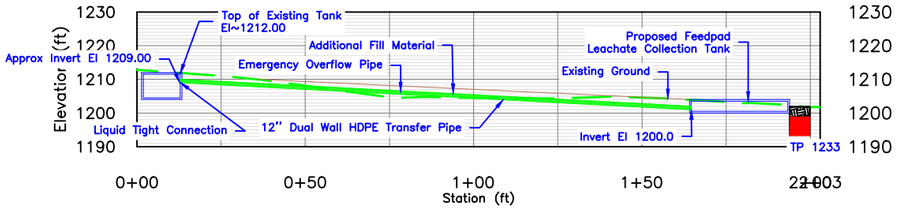
Emerald Sky Dairy, LLC

8/10/2017

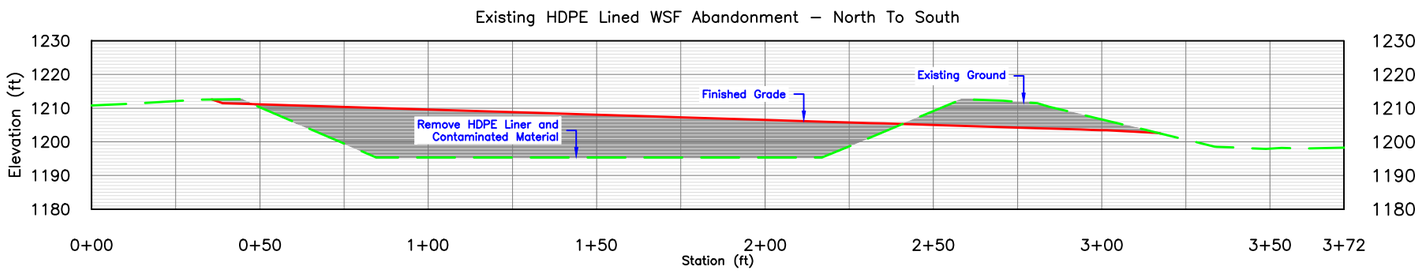
Separation Building 8" Transfer Cross Section #1



Separation Building 12" Transfer Cross Section #1 – West To East

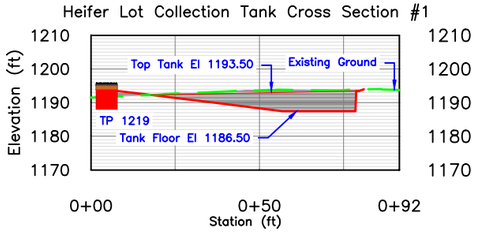


Existing HDPE Lined WSF Abandonment – North To South

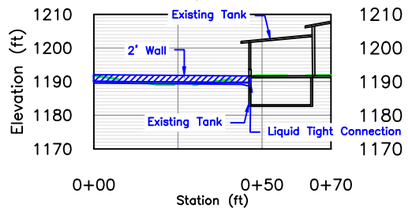


- Topsoil
- Disturbed
- ML
- CL
- GP
- SM
- SC
- SP

Heifer Lot Collection Tank Cross Section #1



Calf Lot Into Existing Tank Cross Section #1



GRAPHIC SCALE

45 0 22.50 45 90

(IN FEET)

1 inch = 45 ft.

1 inch = 45 ft. Only If Plotted On 11"x17" Sheet

1 inch = 45 ft Only if Plotted on 11"x17" Sheet

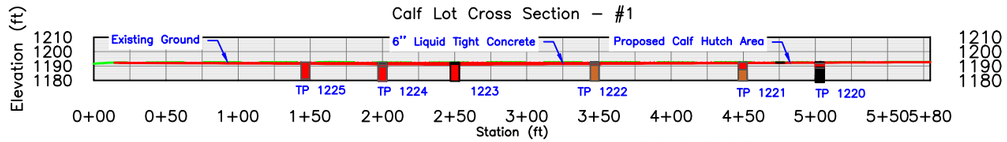
WES PROFESSIONAL ENGINEERING

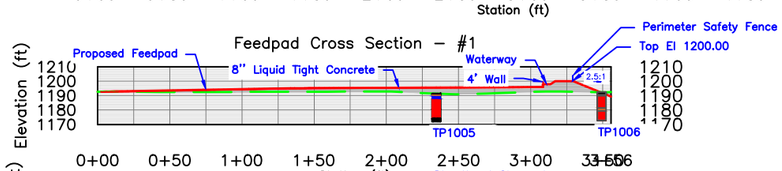
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

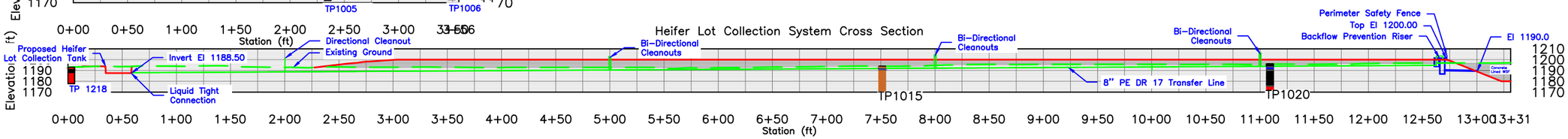
Misc Cross Sections 1

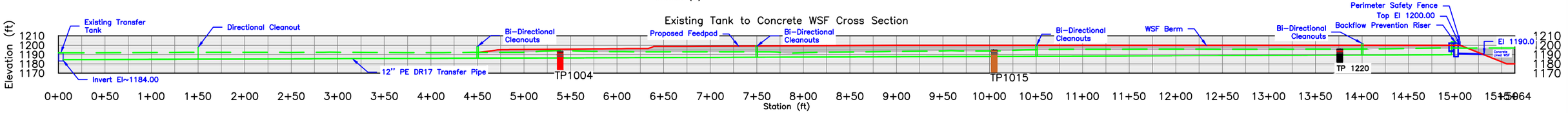
8/9/2017

Emerald Sky Dairy, LLC









Topsoil
Disturbed
ML
CL
GP
SM
SC
SP

GRAPHIC SCALE

105 0 52.50 105 210

(IN FEET)

1 inch = 105 ft.

1 inch = 105 ft. Only If Plotted On 11"x17" Sheet

1 inch = 105 ft Only if Plotted on 11"x17" Sheet

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

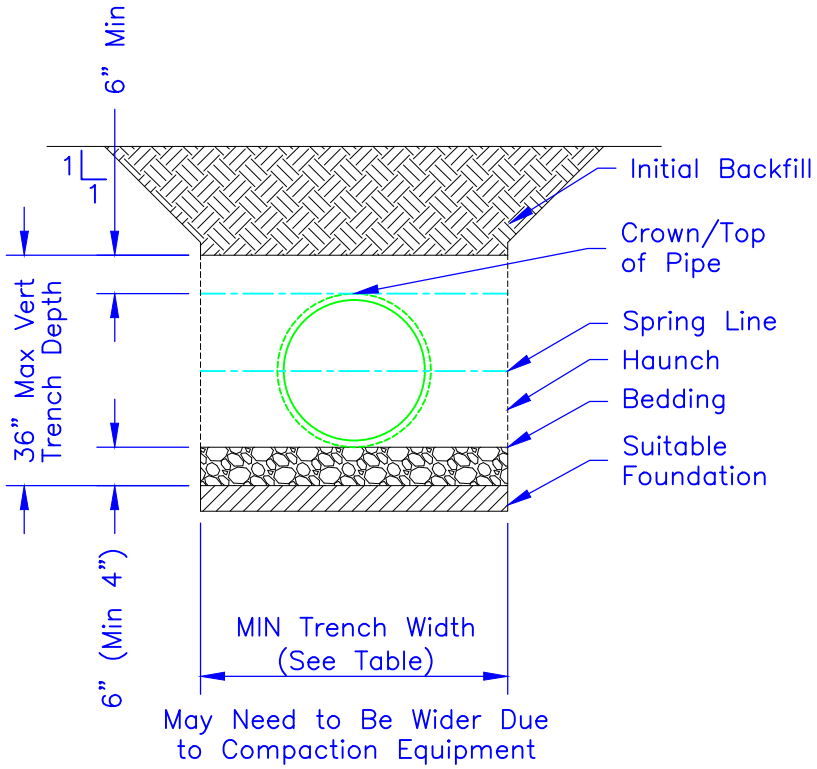
Misc Cross Sections 2

Emerald Sky Dairy, LLC

8/10/2017

Detail Drawings

Waste Storage Facility, Waste Storage Facility Abandonment, Calf Hutch Runoff Collection Pad, Calf Shed Runoff Collection System, Feed Pad Runoff Collection System, Feed Pad & Waste Transfer System



Recommended Minimum Trench Widths

Pipe Dia	Min Trench Width
4"	21"
6"	23"
8"	26"
10"	28"
12"	30"
15"	34"
18"	39"
24"	48"

NOTES:

1. All Pipe Systems Shall Be Installed in Accordance With ASTM D2321, "Standard Practice For Underground Installation of Thermoplastic Pipe For Sewers and Other Gravity Flow Applications", (Latest Edition)

2. FOUNDATION: Where The Trench Bottom is Unstable, The Contractor Shall Excavate To A Depth Required By The Engineer and Replace With Suitable Material as Specified By the Engineer

3. BEDDING: Suitable Material Shall Be Granular Fill. Unless Otherwise Noted By the Engineer, Minimum Bedding Thickness Shall Be 4". Bedding Shall Be Compacted With a Plate Compactor Prior to Pipe Placement

4. HAUNCH: Backfill to Spring Line and Compact Fill With Plate or Jumping Jack Compactor (Plate For Granular Fill, Jumping Jack For Silty/Clayey Backfill)

5. SPRING LINE: Fill From Spring Line to Top of Pipe – Compact With a Plate Compactor Prior to Continued Fill Placement

6. INITIAL BACKFILL: Suitable Material Shall Be Granular Fill in The Pipe Zone Extending Not Less Than 6" Above Crown of Pipe. Material Shall Be Installed as Required in ASTM D2321 (Latest Edition)

7. MINIMUM COVER: Minimum Desired Soil Cover is 48" to Reduce The Risk of Freezing. Insulation May Be Used Where Minimum Cover is Less Than 48". 2" of High Density Polystyrene May Be Substituted For Each 12" Reduction of Soil Cover Less Than 48".

WES
PROFESSIONAL ENGINEERING

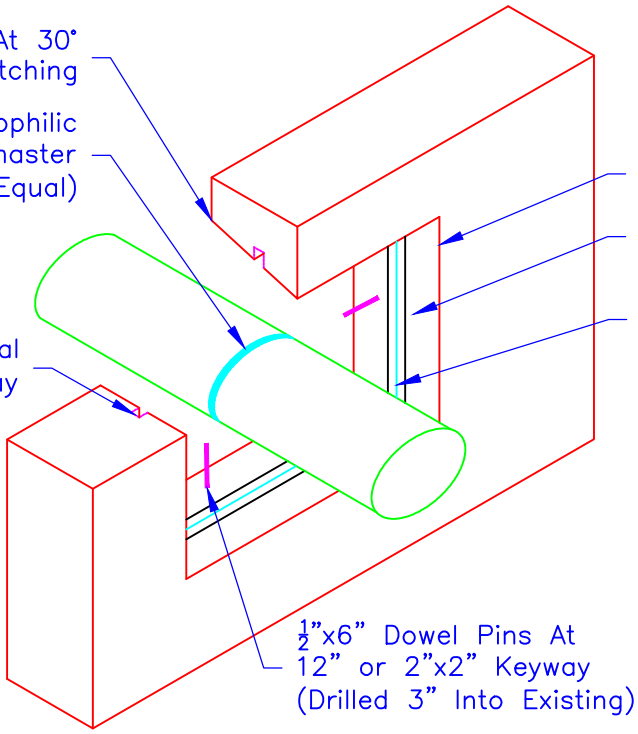
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Pipe Bedding Detail

Emerald Sky Dairy, LLC

Dwg: A1

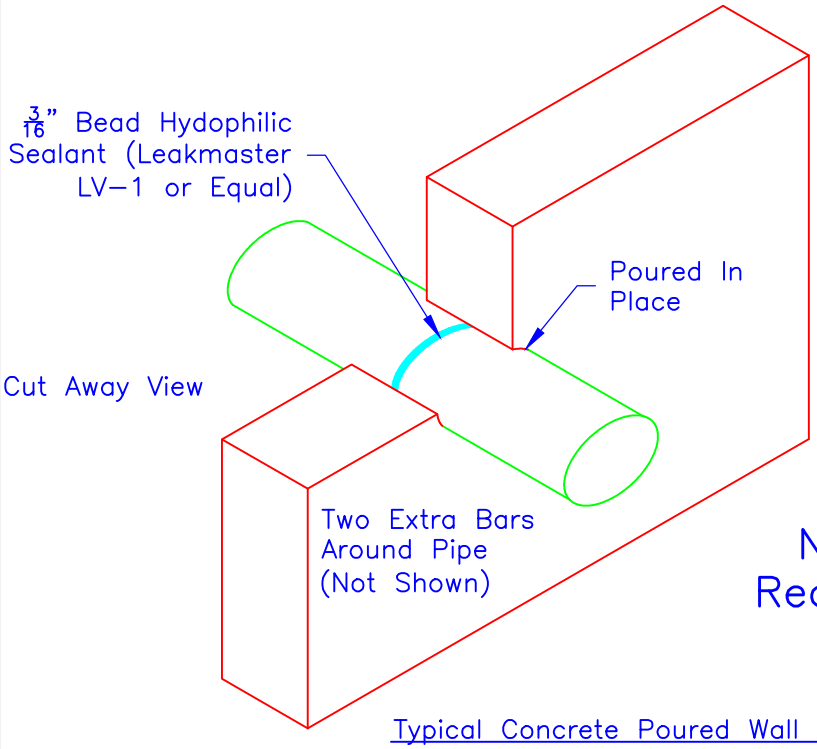
8/10/2017



Typical Manhole/Wall Application

Construction Notes:

1. Vibration is Critical
2. See Plan View For The Pipe Location and Elevation
3. The Sealant Shall Be Applied to Even Surfaces, Free of Dirt, Oil, or Laitance.
4. The Sealant Must Be Bonded to The Concrete and/or Pipe Prior to Placement of Adjoining Concrete. Sealant Shall Cure 24 Hours Prior to Concrete Placement
5. The Manufacturer's Installation Instructions Shall Be Followed For Waterstop Splicing and Additional Installation Requirements
6. Hydrolite Rope May Be Substituted For Leakmaster LV-1

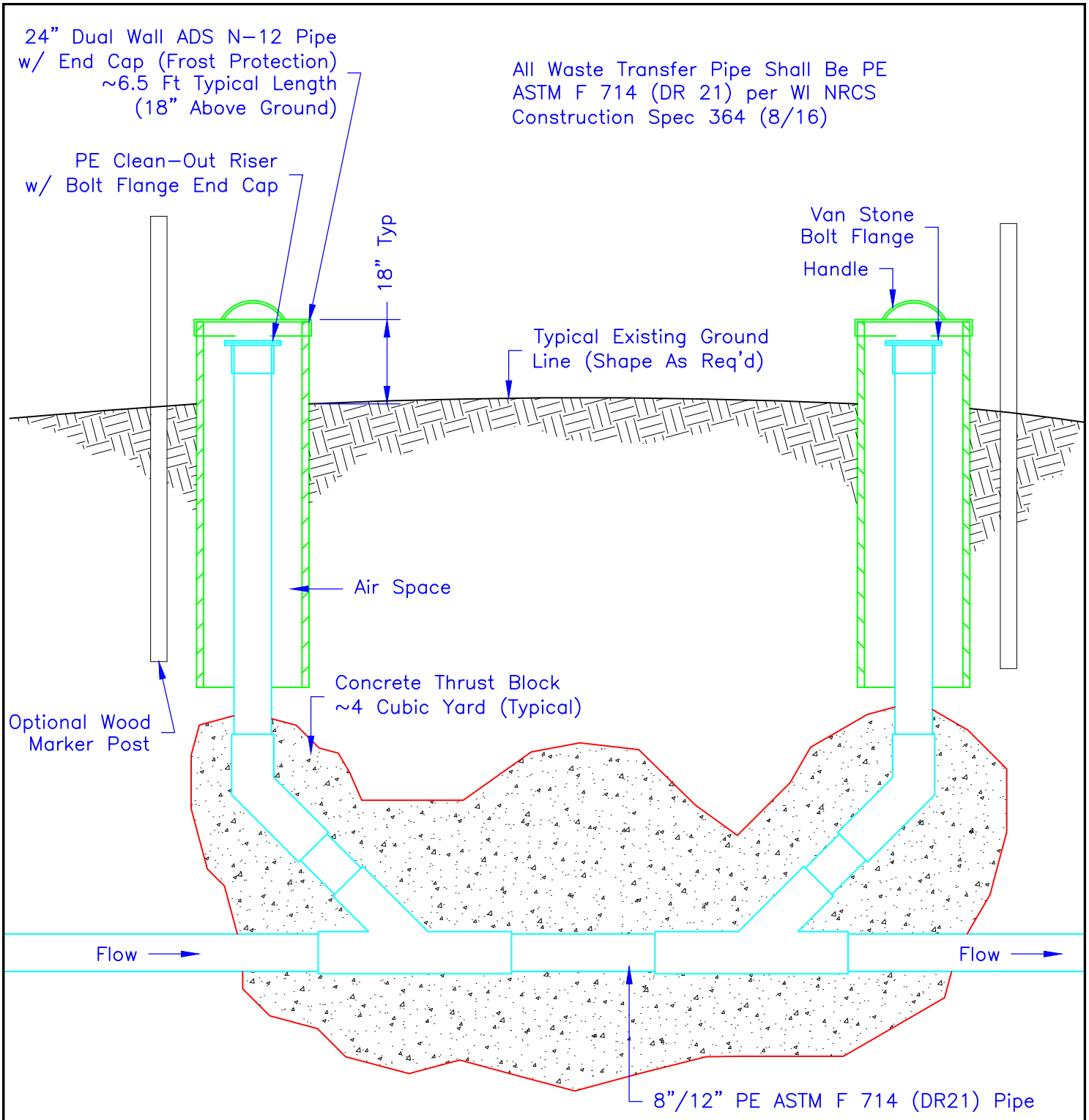


NOTE: Leakmaster LV-1 Requires 24 Hours to Cure

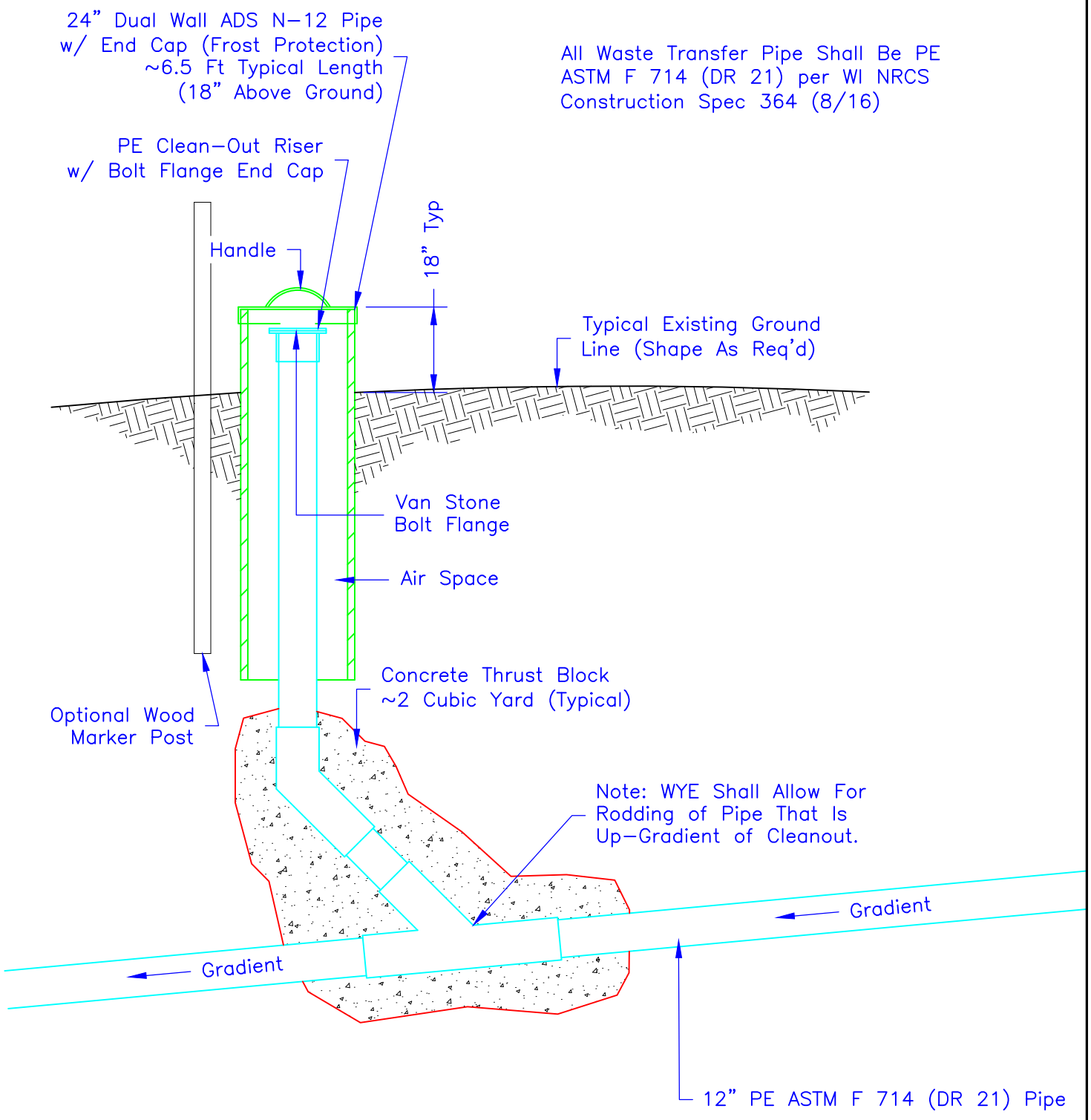
Typical Concrete Poured Wall Application

NOTE:
This Detail Shall Be Used For Manhole Type Applications (Liquid Tight Pipe Penetrations)

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Pipe Penetration Emerald Sky Dairy, LLC	Dwg: A2 8/10/2017



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Bi-Directional Clean-Out Riser (300' Maximum Spacing) Emerald Sky Dairy, LLC	Dwg: A3 8/10/2017



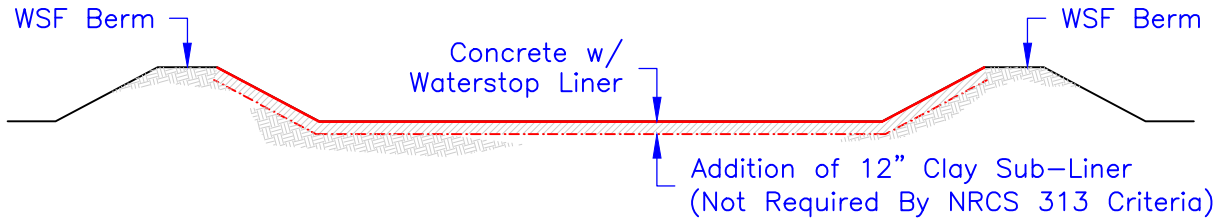
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Single-Directional Clean-Out Riser (150' Maximum Spacing) Emerald Sky Dairy, LLC	Dwg: A3-1 8/10/2017

WI NRCS 313: Table 5 – Concrete Liner Criteria for Impoundments (1/14)

	Concrete with Waterstop	Concrete – Soil Composite			
Soils (Below Liner)					
% Fines	—	≥20%	≥20%	≥20%	Foundry Sand
Plasticity Index (PI)	—	≥7	—	≥20%	—
Thickness	—	≥1.5ft	≥3ft	≥ 8 inches	≥1.5ft
Compaction of Material	WI Spec 204	WI Spec 204	WI Spec 204	WI Spec 300	WI Spec 204
Separation Distance					
Sinkholes	≥400ft	≥400ft	≥400ft	≥400ft	≥400ft
Well Distance	≥100ft	≥100ft	≥100ft	≥100ft	≥100ft
Subsurface Saturation	≥ 2ft (1ft for sump)	≥4ft (3ft for sump)	≥5ft (4ft for sump)	≥ 3ft (2ft for sump)	≥4ft (3ft for sump)
Bedrock	≥ 2ft (1ft for sump)	≥4ft (3ft for sump)	≥5ft (4ft for sump)	≥ 3ft (2ft for sump)	≥4ft (3ft for sump)
Impoundment					
Inside Slope	2.5:1 or flatter	2:1 or flatter			

Waste Storage Facility Shall Meet These Requirements/Specifications

Stage 1 Concrete Waste Storage Facility



WES PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

Concrete Liner Criteria

Emerald Sky Dairy, LLC

Dwg: A10

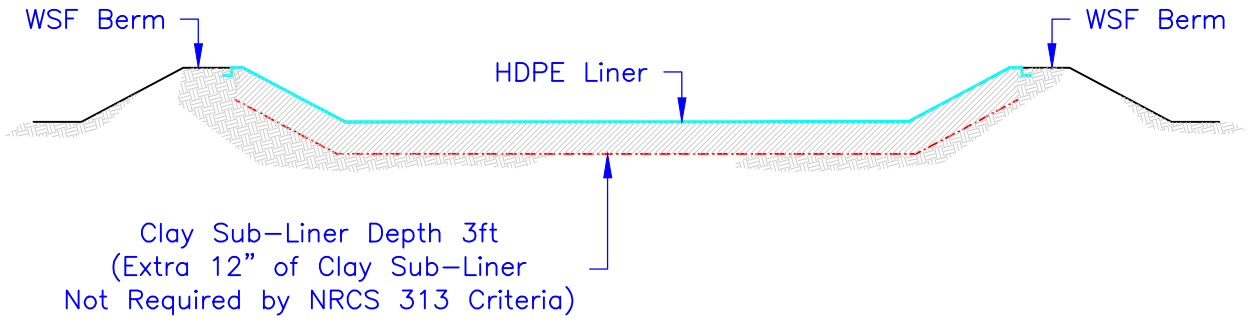
8/10/2017

WI NRCS 313: Table 3 – Geomembrane Liner Criteria for Impoundments (1/14)

Liner Material		
	60 mil High Density Polyethylene (HDPE) or 60 mil Liner Low Density Polyethylene (LLDPE) or 60 mil Ethylene Propylene Diene Monomer (EPDM). The geomembrane shall be installed with intimate contact to the soil below.	
Soils (Directly Below Liner)		
% Fines	≥40%	≥40%
Plasticity Index (PI)	≥7	–
Thickness	≥2 ft.	≥2 ft.
Compaction of Material	WI Spec 204	WI Spec 204
Subgrade Prepartion	WI Spec 202 or 205	WI Spec 202 or 205
Separation Distance		
Well Distance	≥250 ft.	≥250 ft.
Sinkholes	≥400 ft.	≥400 ft.
Subsurface Saturation	≥4 ft.	≥6 ft.
Bedrock	≥4 ft.	≥6 ft.
Impoundment		
Inside Slope	2.5:1 or flatter	

Waste Storage Facility Shall Meet These Requirements/Specifications

Stage 2 HDPE Waste Storage Facility



WES
PROFESSIONAL ENGINEERING

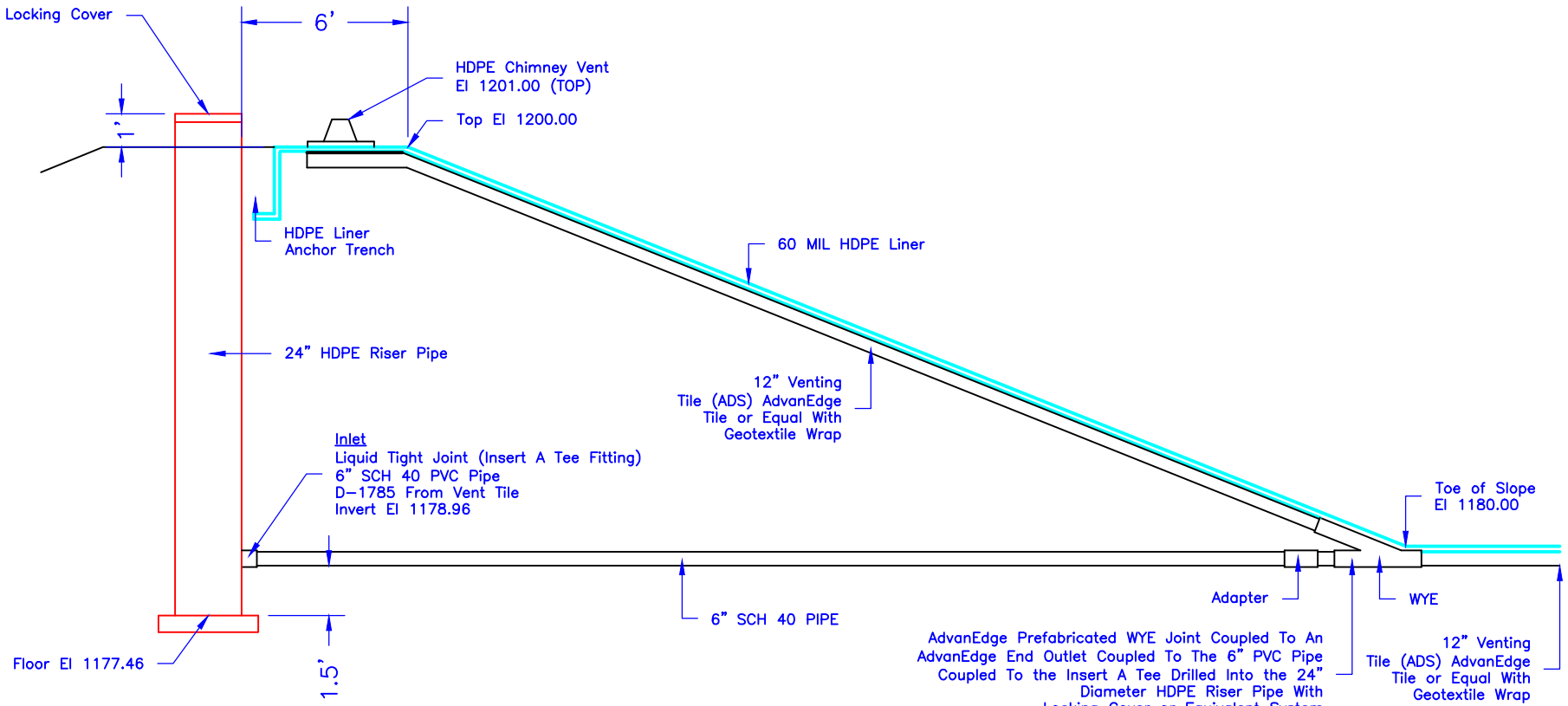
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

HDPE Liner Criteria

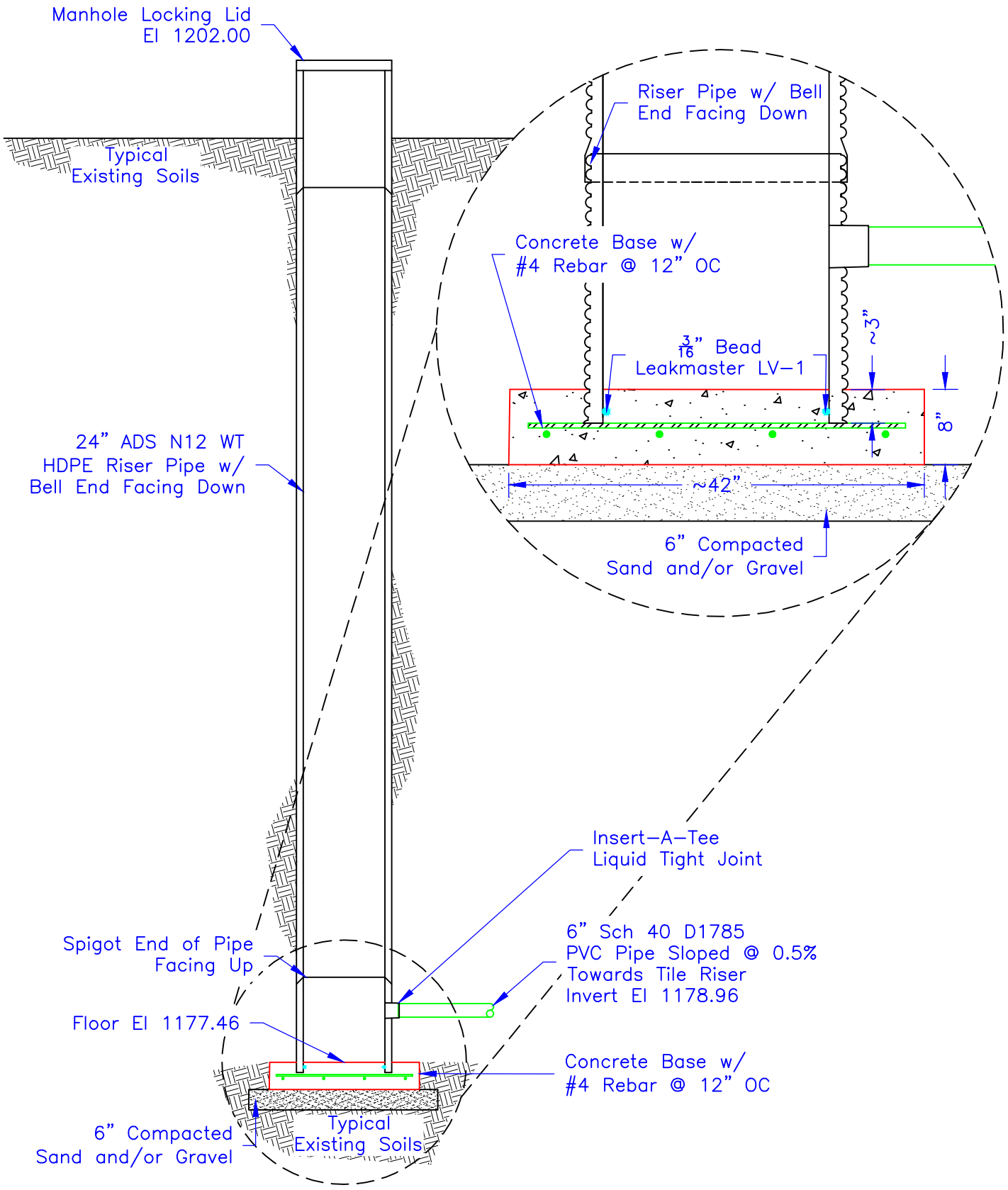
Emerald Sky Dairy, LLC

Dwg: A10–1

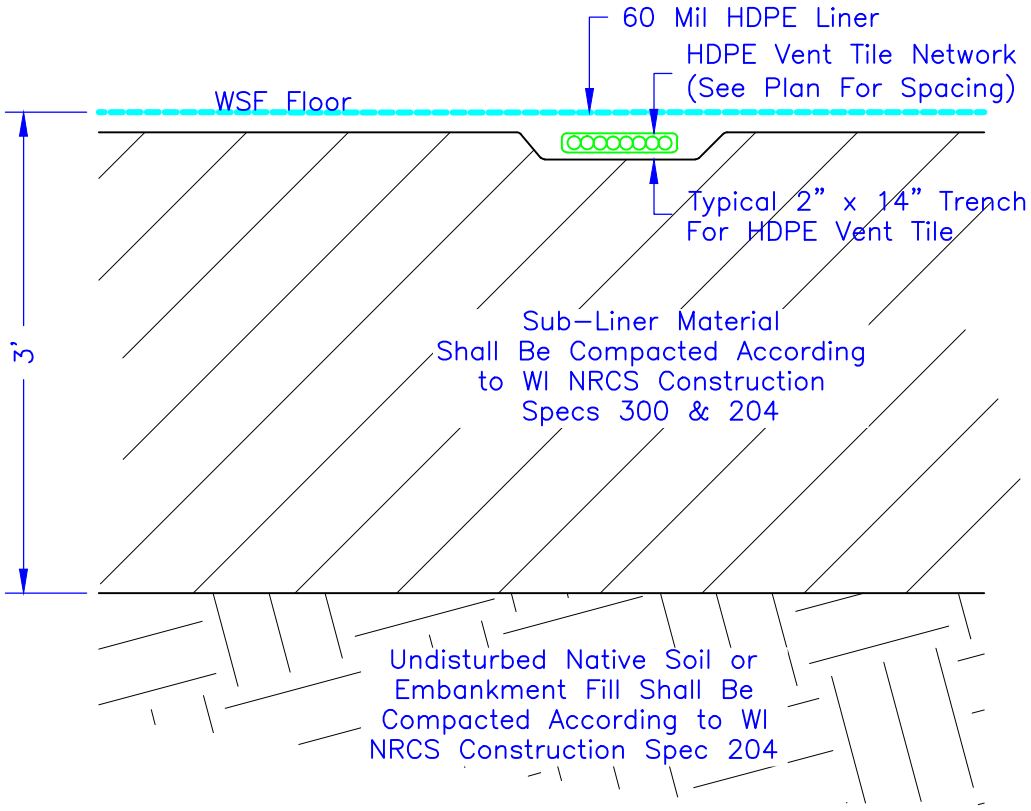
8/10/2017



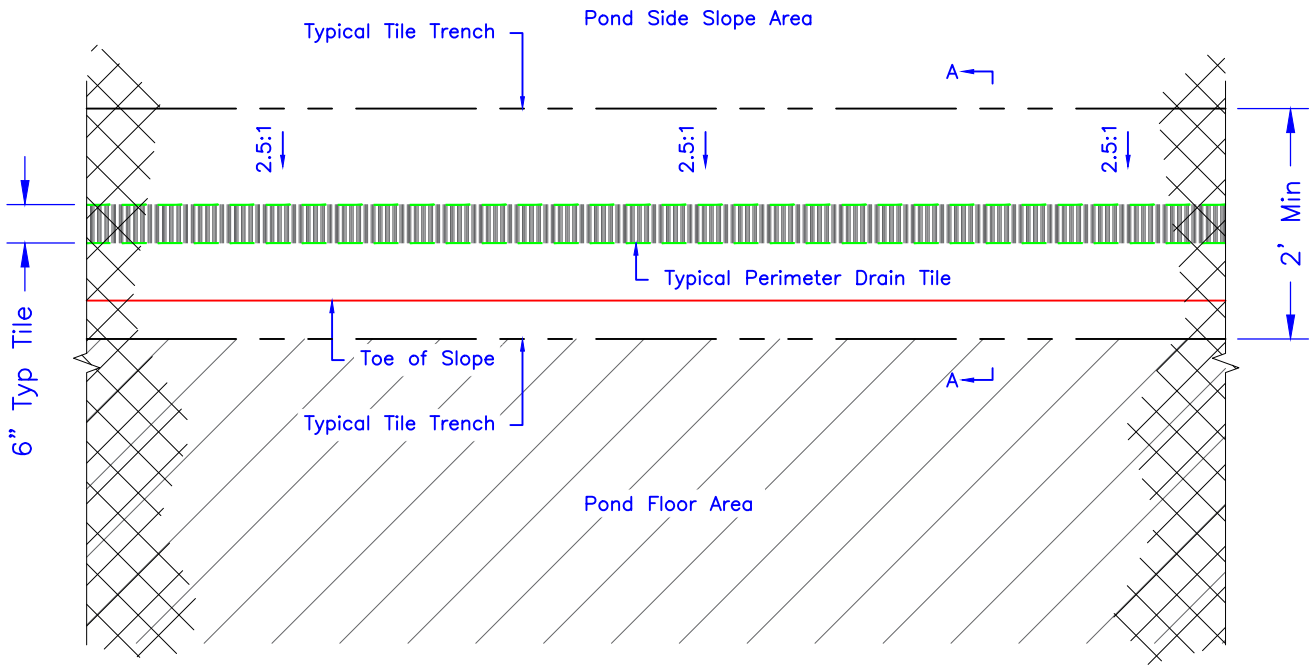
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Venting Tile Manhole Emerald Sky Dairy, LLC	Dwg: F16 8/10/2017 115 of 258



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical HDPE Pipe Vent Tile Lift Station Emerald Sky Dairy, LLC	Dwg: A18 8/10/2017

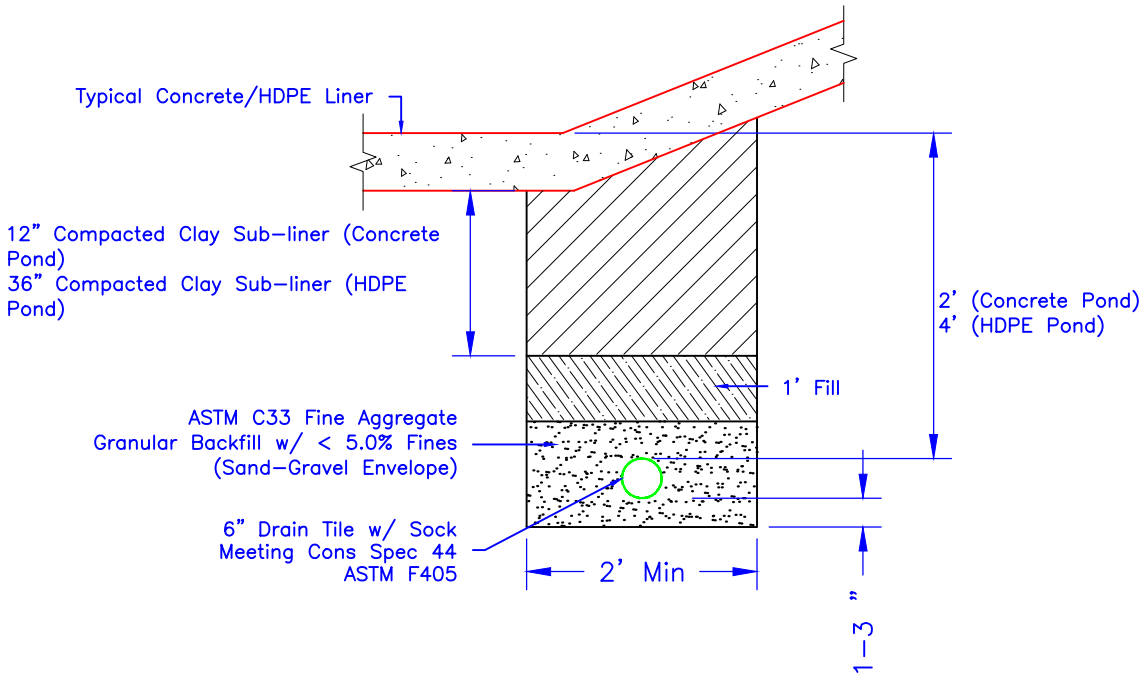


WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	HDPE Vent Tile Network At WSF Floor Emerald Sky Dairy, LLC	Dwg: J16 8/10/2017



Plan View

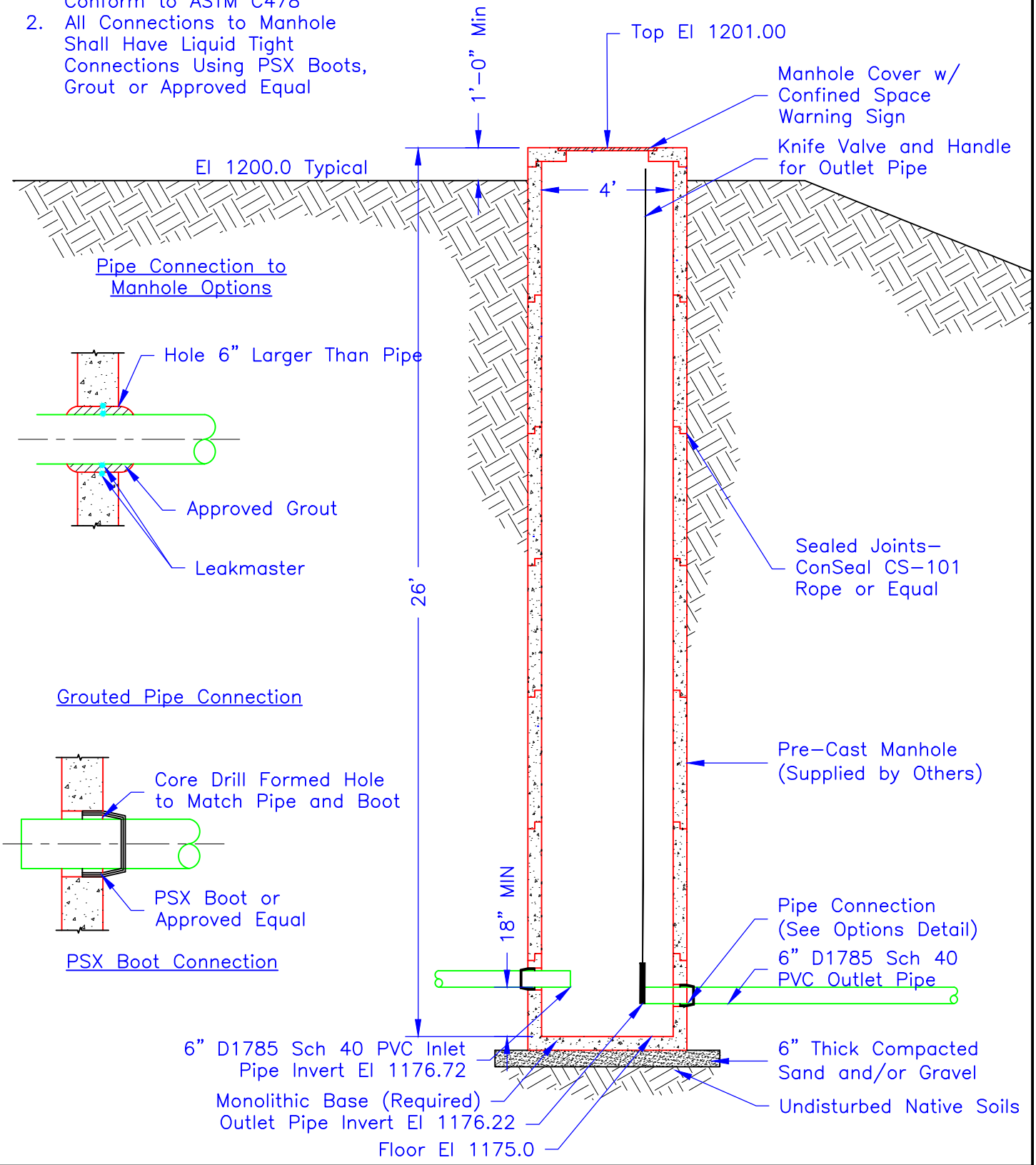
Envelope Material As Defined By NRCS Standard 606. Sand–Gravel Envelope Materials Shall All Pass A 1.5 Inch Sieve; Not More Than 30% Shall Pass a #60 Sieve; and Not More Than 5% Shall Pass the 200 Sieve



Section A–A

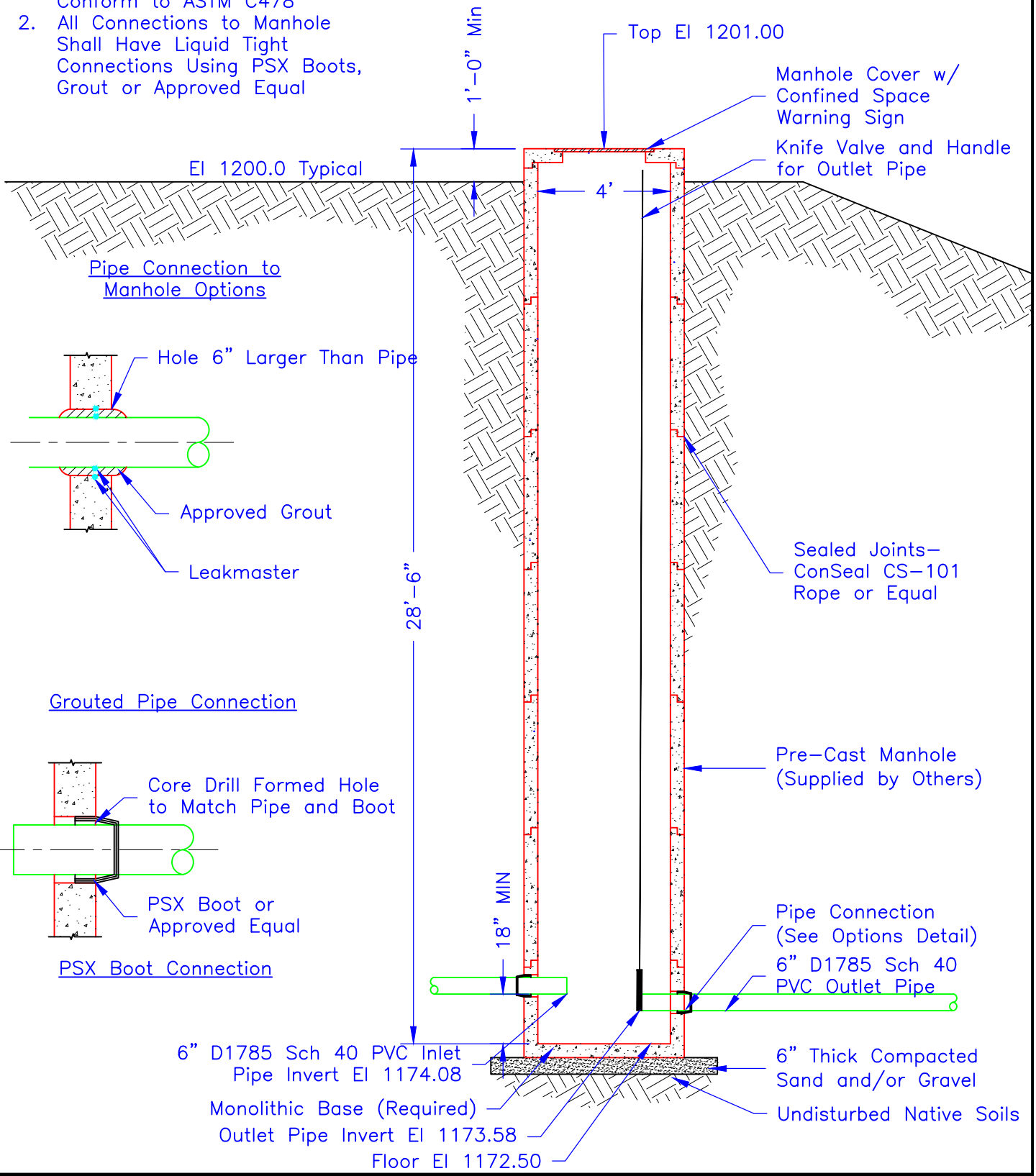
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Perimeter Drain Tile Concrete/HDPE Ponds Emerald Sky Dairy, LLC	Dwg: C6 8/10/2017

Note:
1. All Manhole Sections to Conform to ASTM C478
2. All Connections to Manhole Shall Have Liquid Tight Connections Using PSX Boots, Grout or Approved Equal

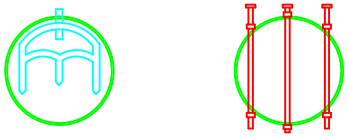


WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Perimeter Drain Tile Lift Station At Concrete WSF Emerald Sky Dairy, LLC	Dwg: F7 8/10/2017

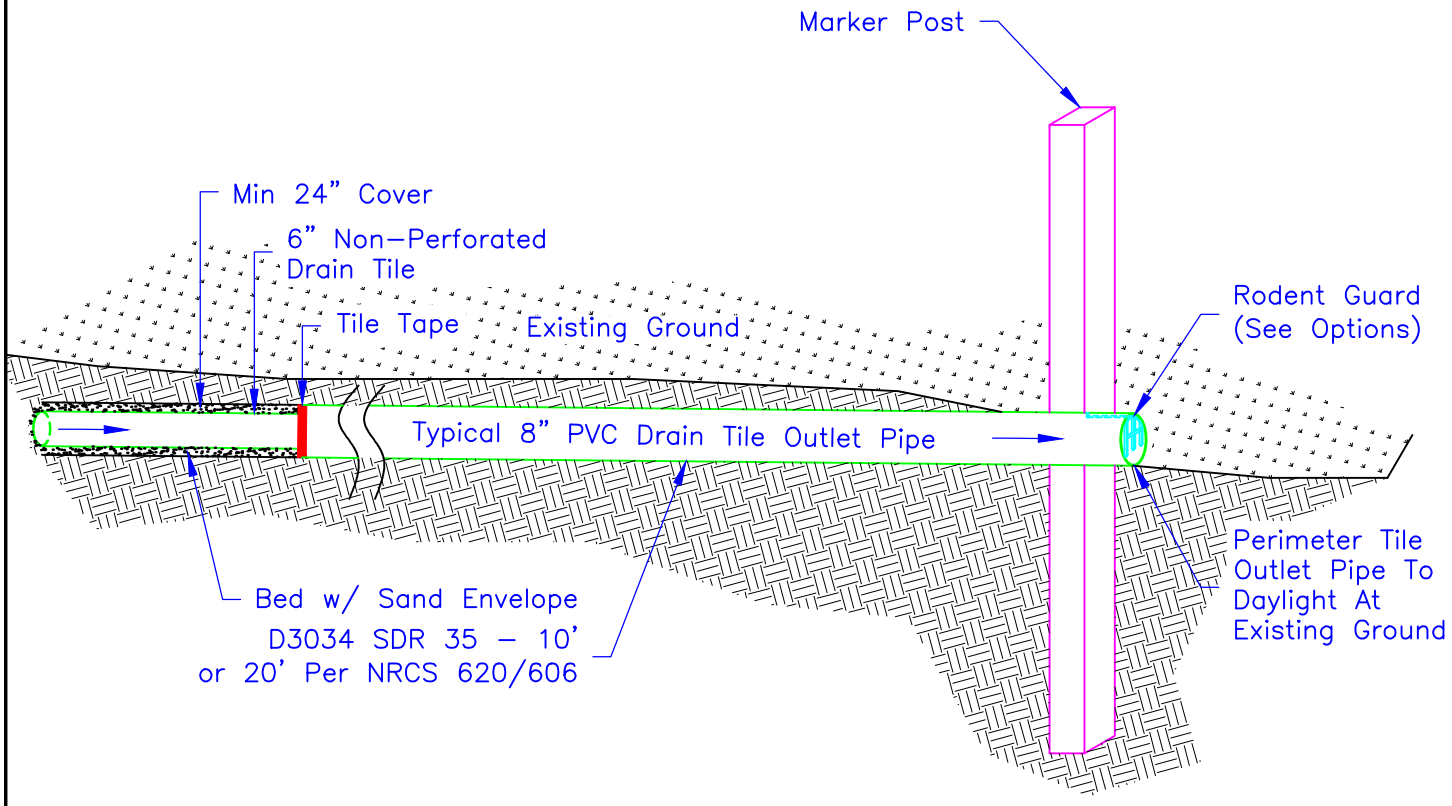
Note:
1. All Manhole Sections to Conform to ASTM C478
2. All Connections to Manhole Shall Have Liquid Tight Connections Using PSX Boots, Grout or Approved Equal



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Perimeter Drain Tile Lift Station At HDPE WSF Emerald Sky Dairy, LLC	Dwg: F7-1 8/10/2017



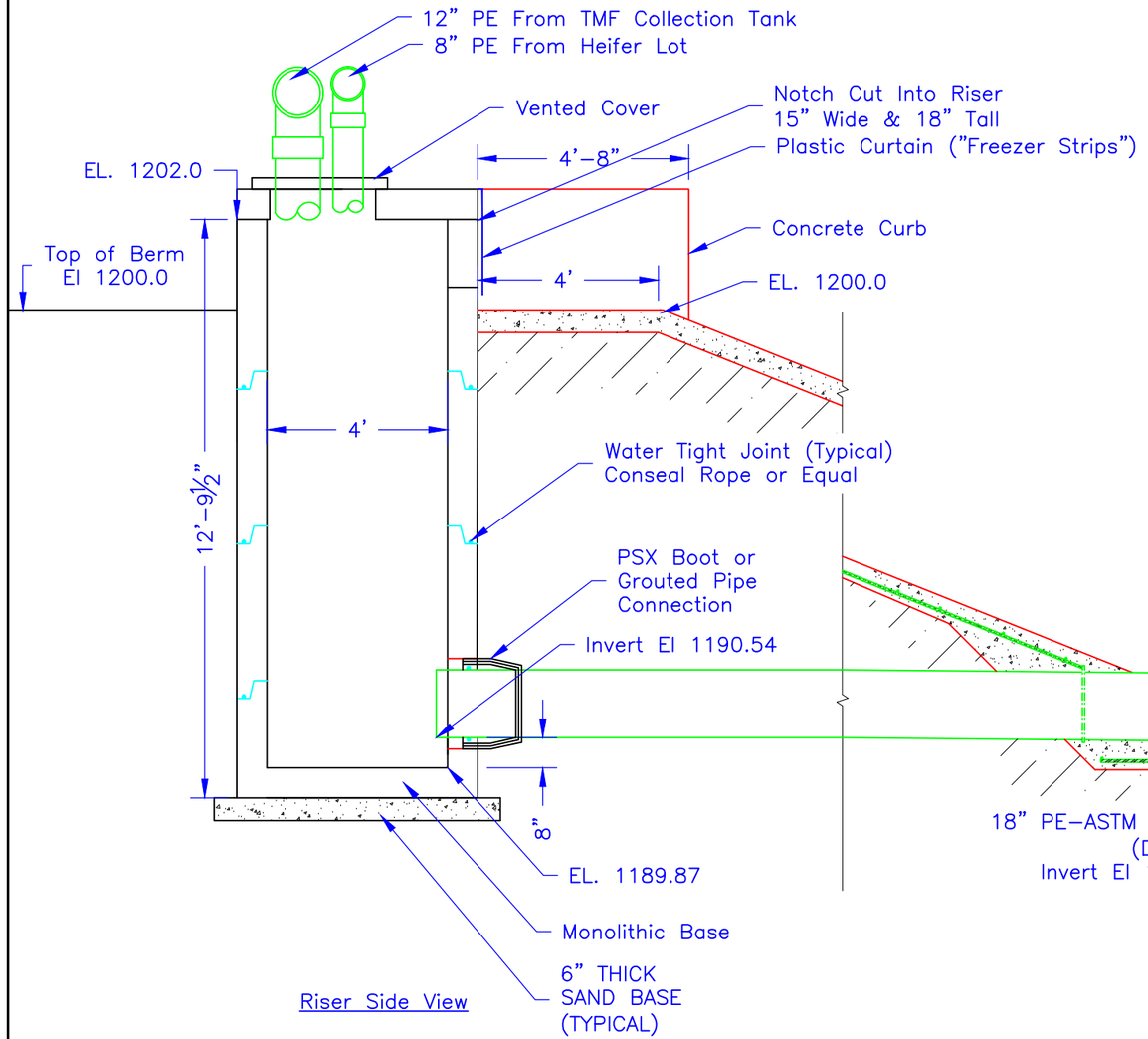
Rodent Guard Options



Note:
Preferred Pipe Shall Be PVC D3034 SDR 35 or D1785 Sch 40 Entire Length (Pond To Outlet). The Outlet Pipe Shall Be Connected To The HDPE Perimeter Tile Lift Station Manhole At The Waste Storage Facility and Shall Be Sloped At 0.10% Slope Towards The Perimeter Tile Outlet Location. The Outlet Shall Be Marked With A Post and The Pipe Opening Shall Be Protected With A Rodent Guard.

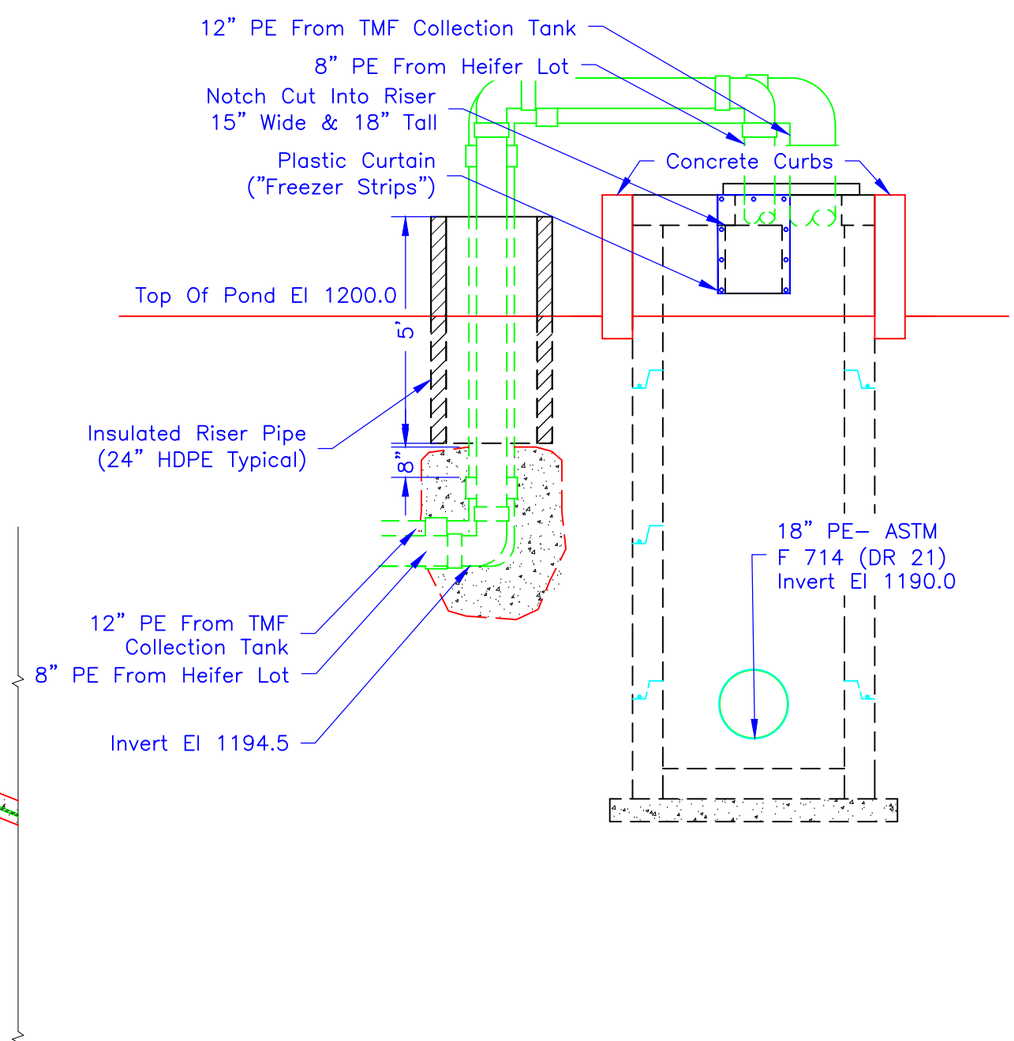
(See Plan For Invert Elevations of Pipe)

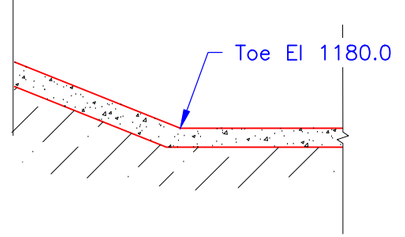
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Perimeter Tile Outlet Pipe w/ Marker Post & Rodent Guard Emerald Sky Dairy, LLC	Dwg: A5 8/10/2017

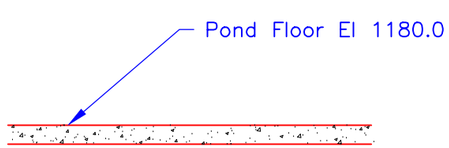


Riser Side View

NOTE:
48" DIAM. DUAL WALL HDPE PIPE MAY BE USED INSTEAD OF PRECAST MANHOLE (IF FACTORY PRE-MANUFACTURED FITTING USED ON OUTLET PIPE INTO POND)







Riser Front View

NOTE:
1. THE MANHOLE MUST HAVE A VENTED COVER.
2. THE MANHOLE IS A CONFINED SPACE. FOLLOW ASAE EP470, MANURE STORAGE SAFETY, FOR ANY PLANNED ENTRY.
3. THE MANHOLE SHALL CONFORM TO CRITERIA IN ASTM C-478, PRECAST REINFORCED CONCRETE MANHOLE SECTIONS.
4. PLACE RIGID STYROFOAM INSULATION, 4 FEET WIDE, OVER THE PIPE WHEREVER THERE IS LESS THAN 3' OF COVER. 2" OF STYROFOAM REPLACES APPROXIMATELY ONE FOOT OF SOIL.
5. APPLY HYDROPHILIC SEALANT AND NON-SHRINK GROUT AT PIPE OPENINGS. (UNLESS PSX BOOT IS USED)
6. A RUBBER BOOT CONNECTOR (PSX) IS A PREFERRED ALTERNATIVE TO GROUTING THE PIPE (A-LOK, PRESS SEAL (PSX), OR EQUIVALENT.)
7. A PRECAST RISER SECTION WITH INTEGRAL BASE IS REQUIRED.
8. CONCRETE THRUST BLOCK AROUND BURIED PIPE ELBOWS NOT SHOWN.
9. PIPE INSULATION AND PROTECTIVE TUBE RECOMMENDED.

WES
PROFESSIONAL ENGINEERING

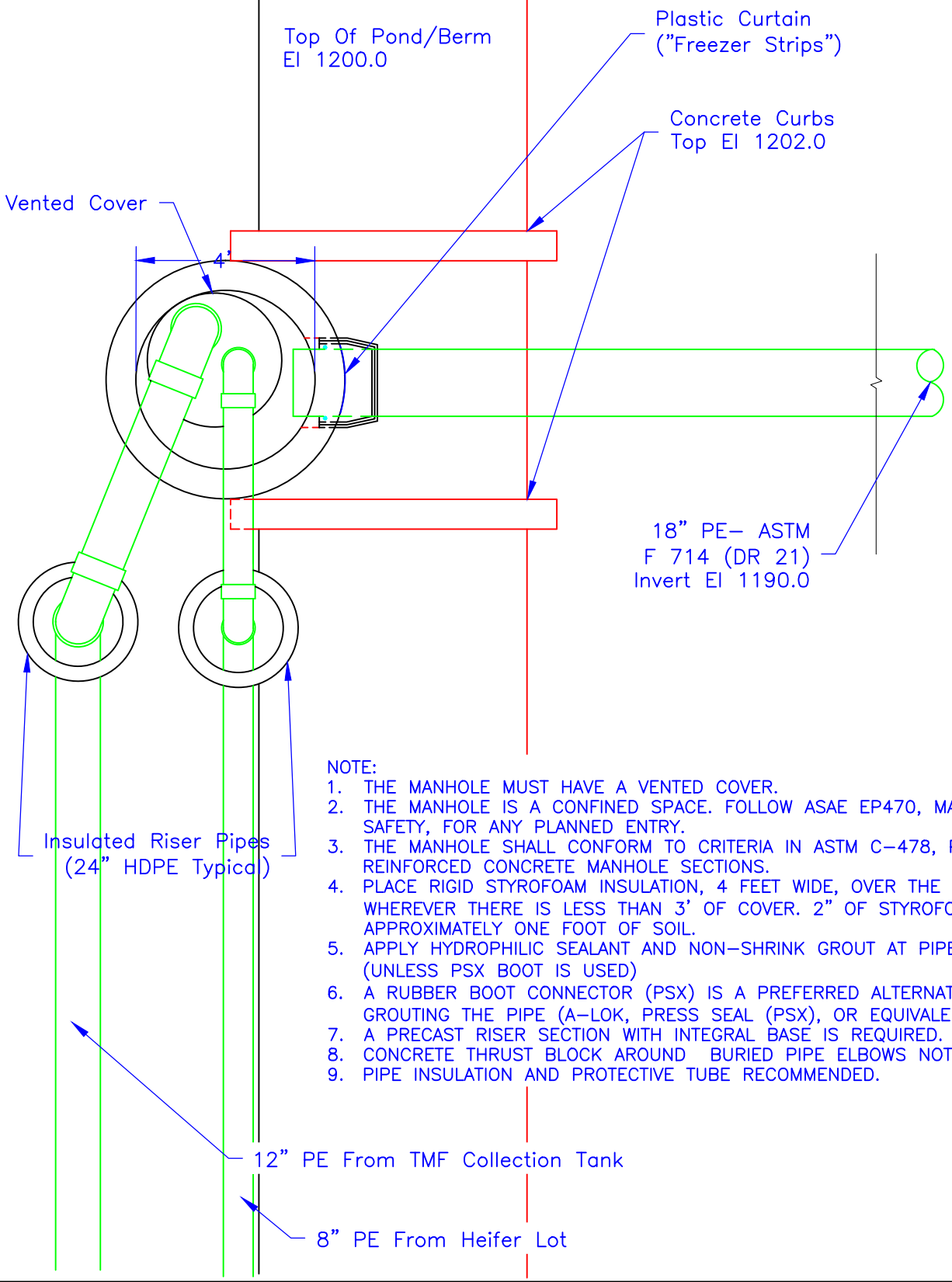
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Backflow Prevention Riser

Emerald Sky Dairy, LLC

Dwg: A16

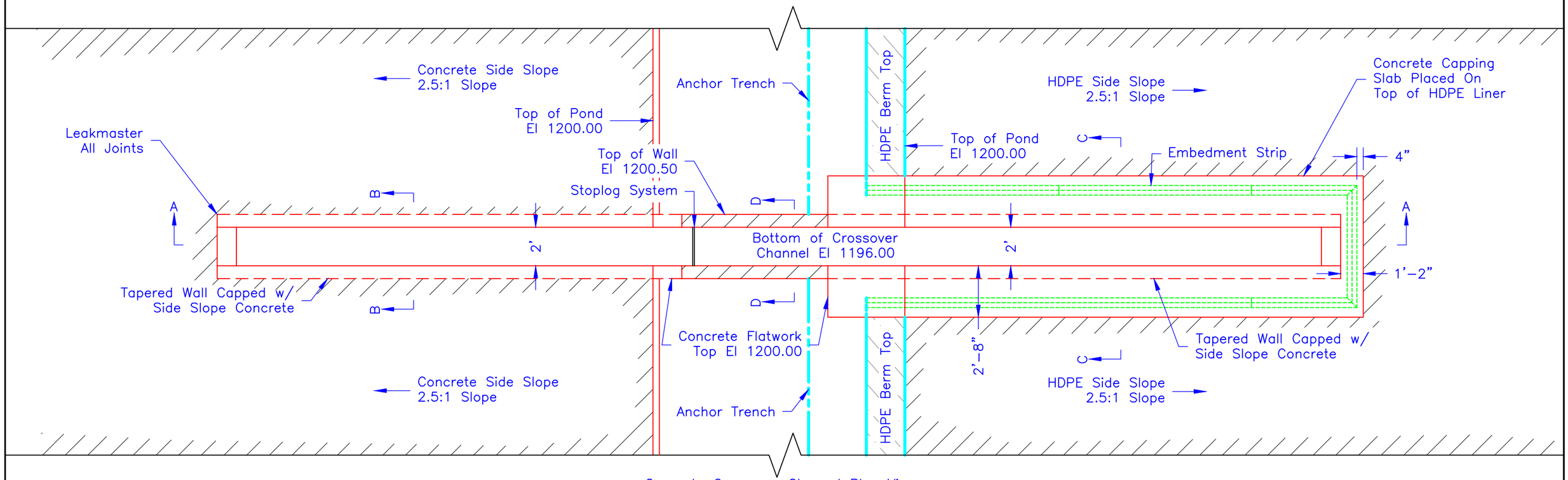
8/10/2017



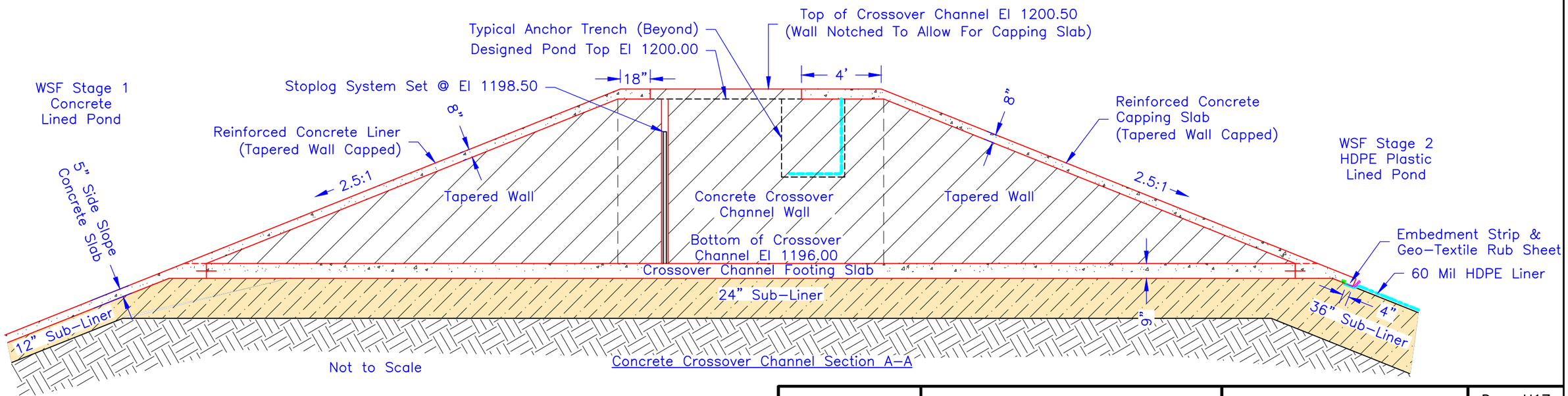
NOTE:

1. THE MANHOLE MUST HAVE A VENTED COVER.
2. THE MANHOLE IS A CONFINED SPACE. FOLLOW ASAE EP470, MANURE STORAGE SAFETY, FOR ANY PLANNED ENTRY.
3. THE MANHOLE SHALL CONFORM TO CRITERIA IN ASTM C–478, PRECAST REINFORCED CONCRETE MANHOLE SECTIONS.
4. PLACE RIGID STYROFOAM INSULATION, 4 FEET WIDE, OVER THE PIPE WHEREVER THERE IS LESS THAN 3' OF COVER. 2" OF STYROFOAM REPLACES APPROXIMATELY ONE FOOT OF SOIL.
5. APPLY HYDROPHILIC SEALANT AND NON–SHRINK GROUT AT PIPE OPENINGS. (UNLESS PSX BOOT IS USED)
6. A RUBBER BOOT CONNECTOR (PSX) IS A PREFERRED ALTERNATIVE TO GROUTING THE PIPE (A–LOK, PRESS SEAL (PSX), OR EQUIVALENT.)
7. A PRECAST RISER SECTION WITH INTEGRAL BASE IS REQUIRED.
8. CONCRETE THRUST BLOCK AROUND BURIED PIPE ELBOWS NOT SHOWN.
9. PIPE INSULATION AND PROTECTIVE TUBE RECOMMENDED.

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Backflow Prevention Riser Plan View Emerald Sky Dairy, LLC	Dwg: A16 8/10/2017



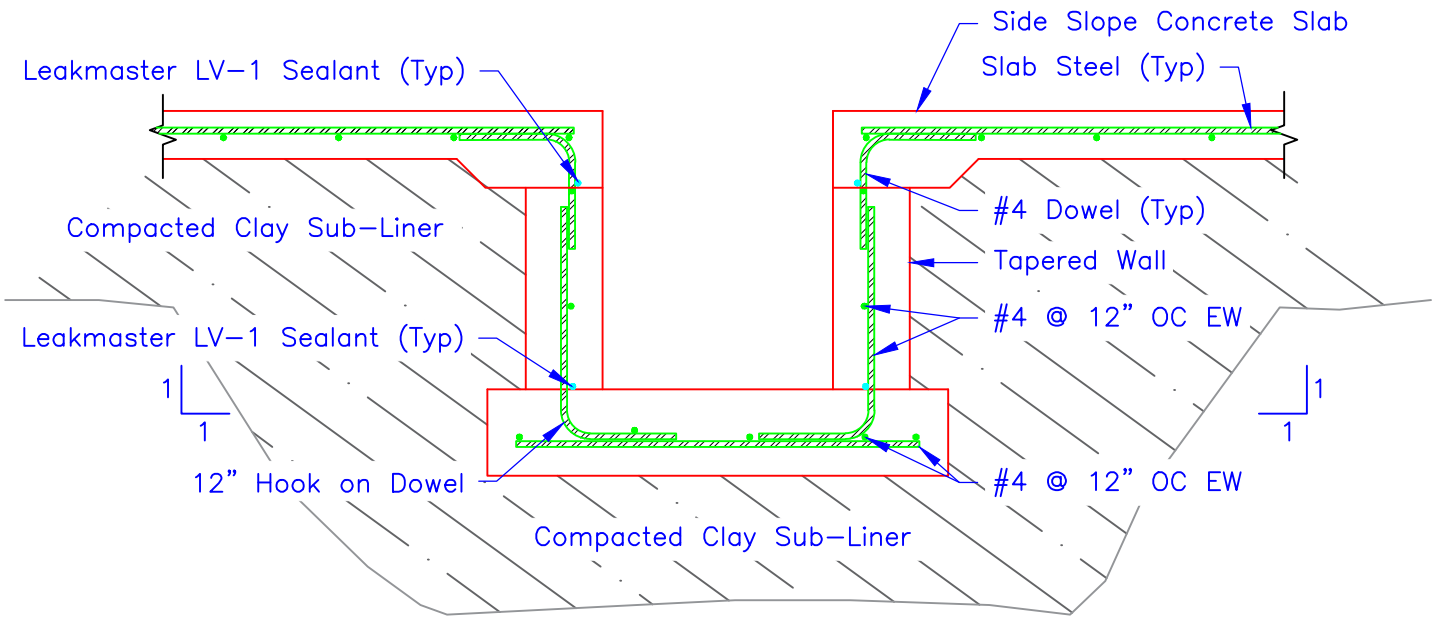
Concrete Crossover Channel Plan View

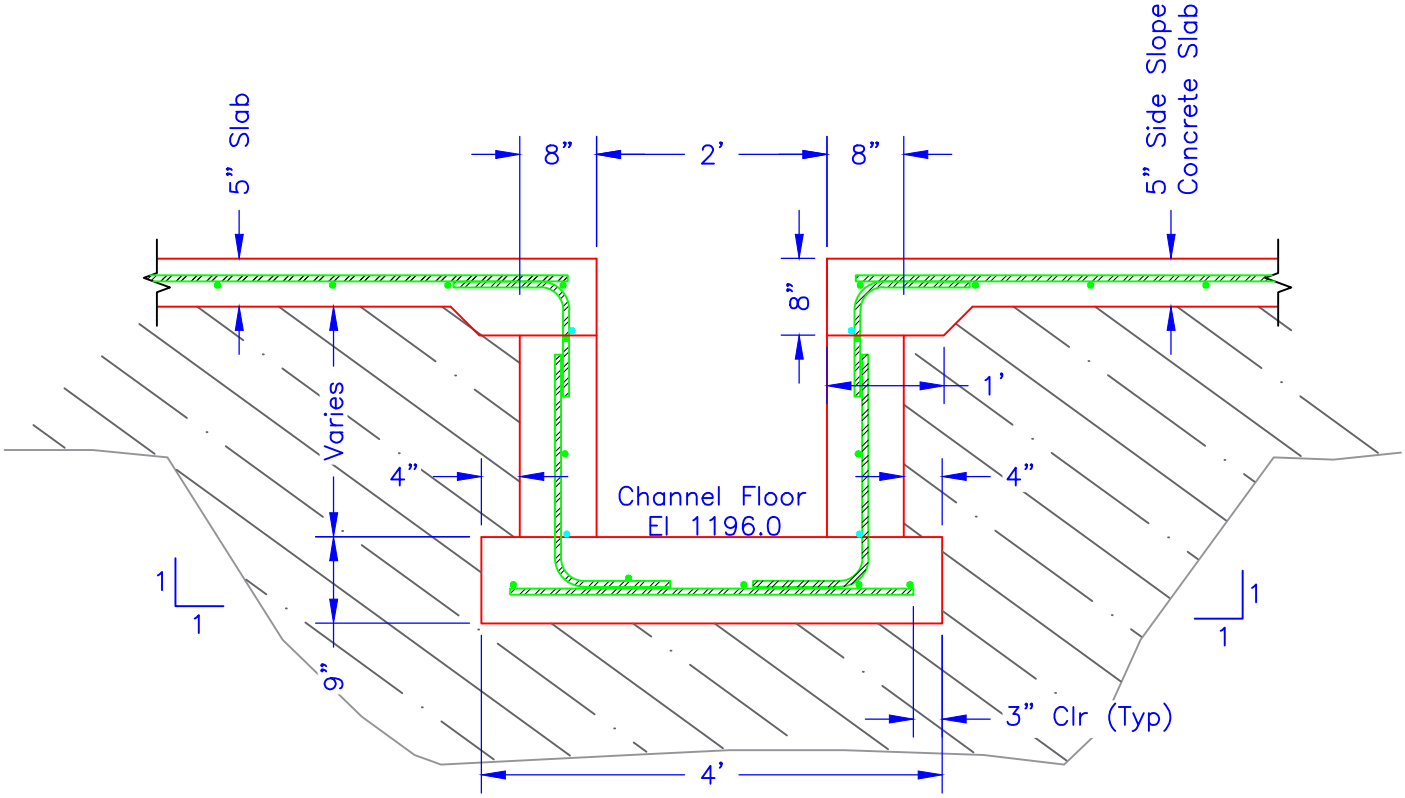


Not to Scale

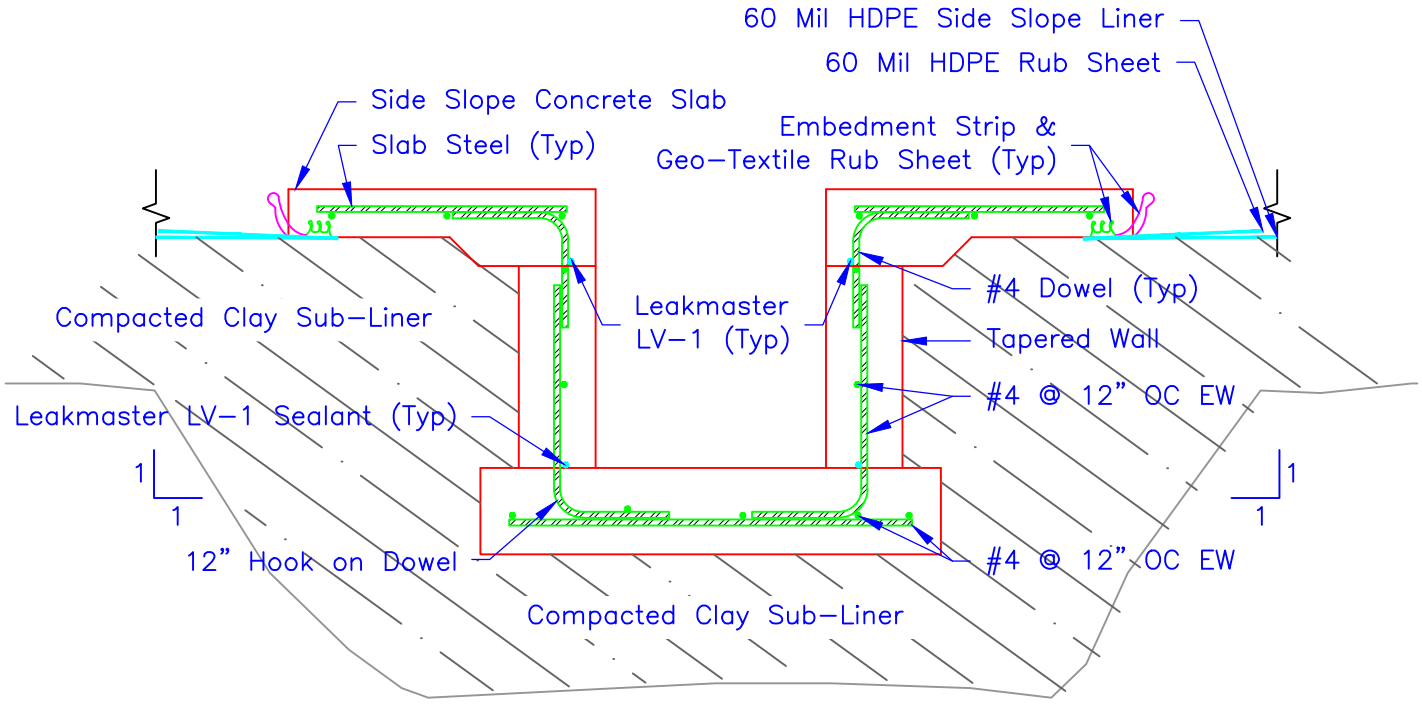
Concrete Crossover Channel Section A-A

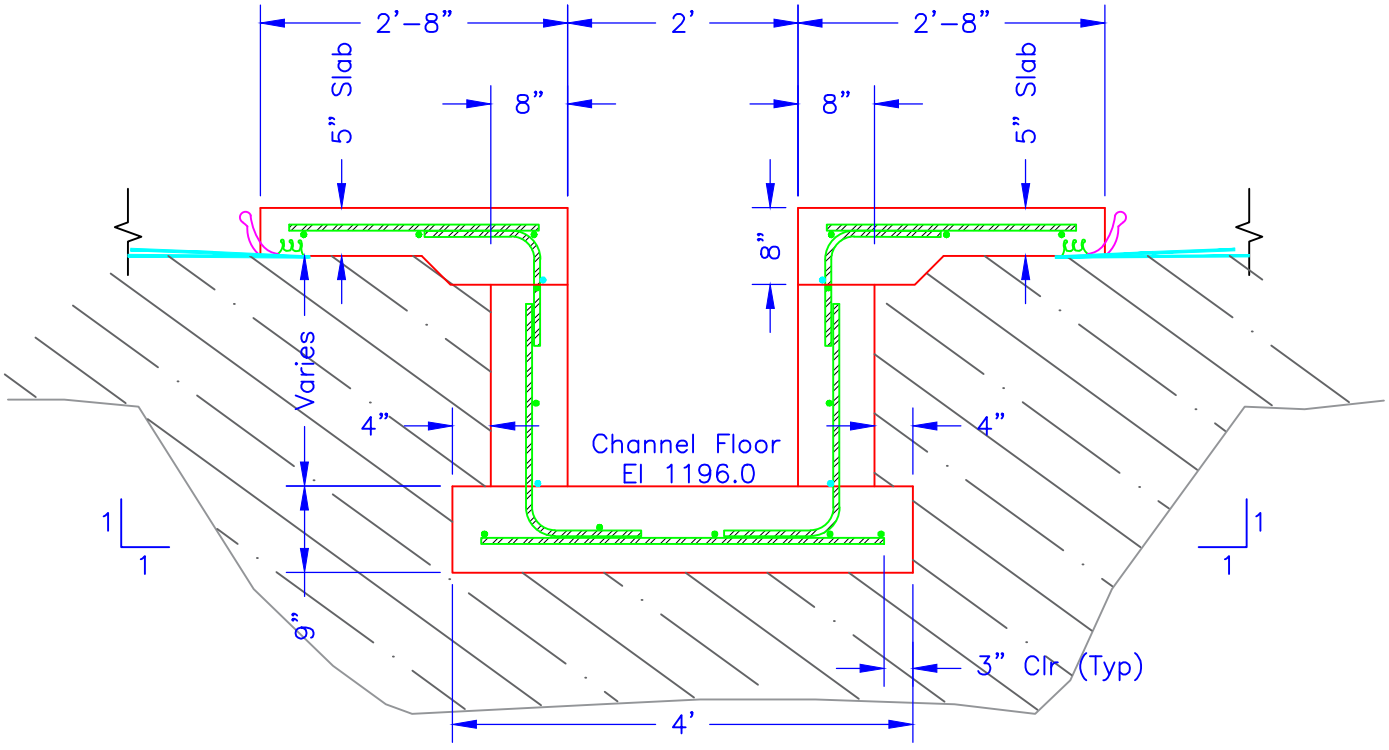
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Embankment Sections Emerald Sky Dairy, LLC	Dwg: H17 8/10/2017



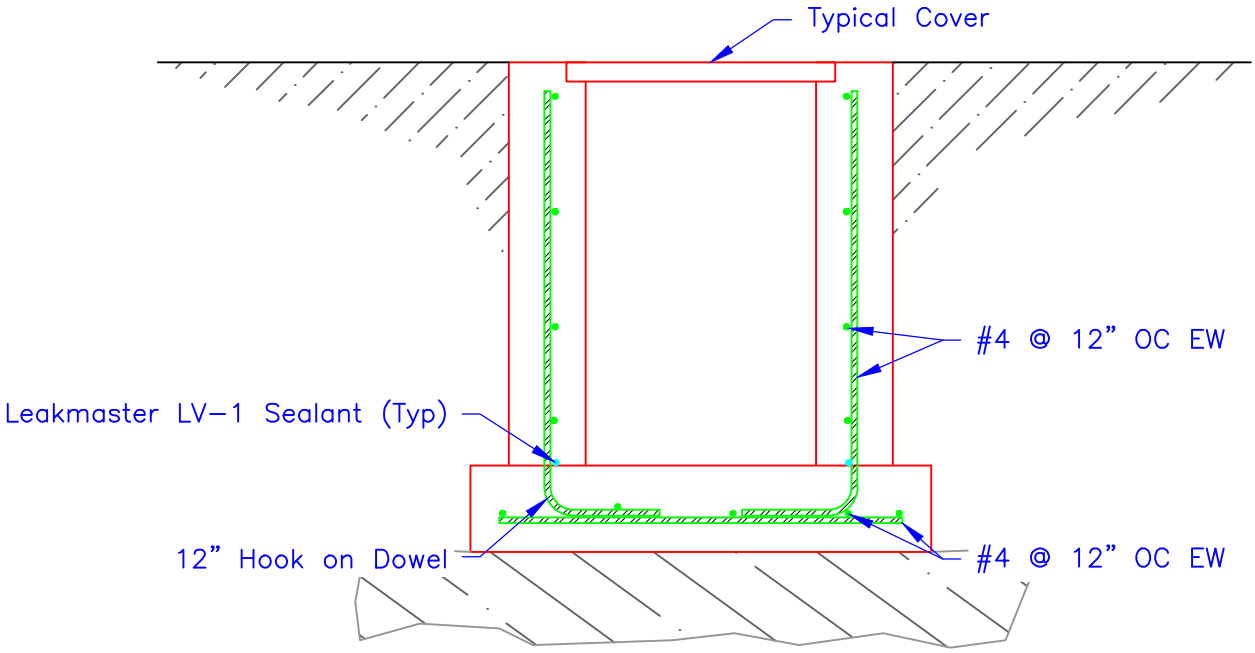


WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Concrete Crossover Channel Section B-B At Concrete Pond Emerald Sky Dairy, LLC	Dwg: H7-1 8/10/2017

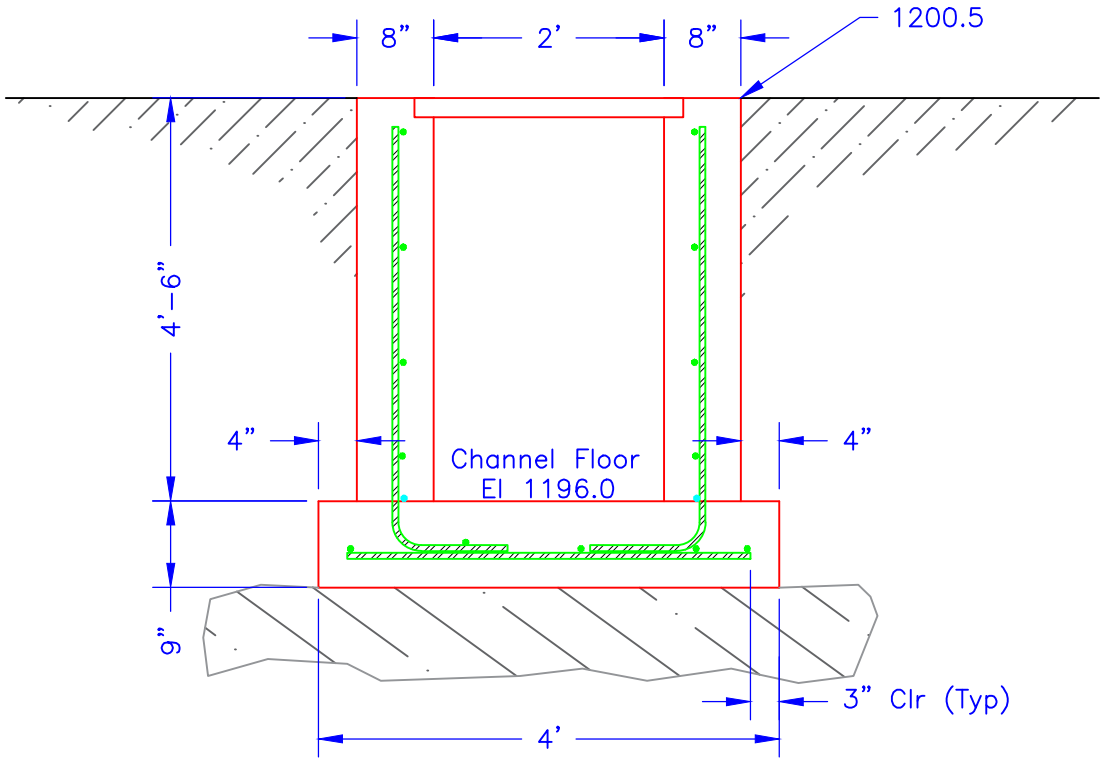




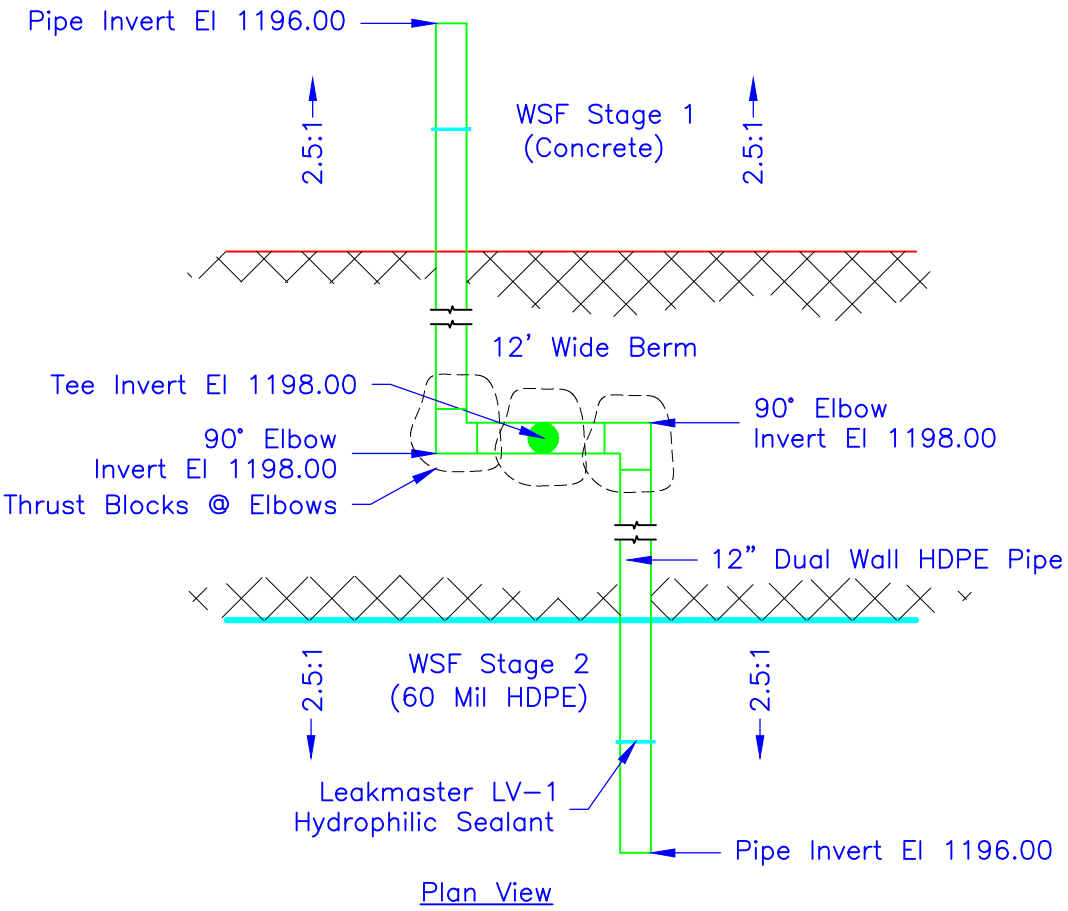
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Concrete Crossover Channel Section C-C At HDPE Pond Emerald Sky Dairy, LLC	Dwg: H17-2 8/10/2017



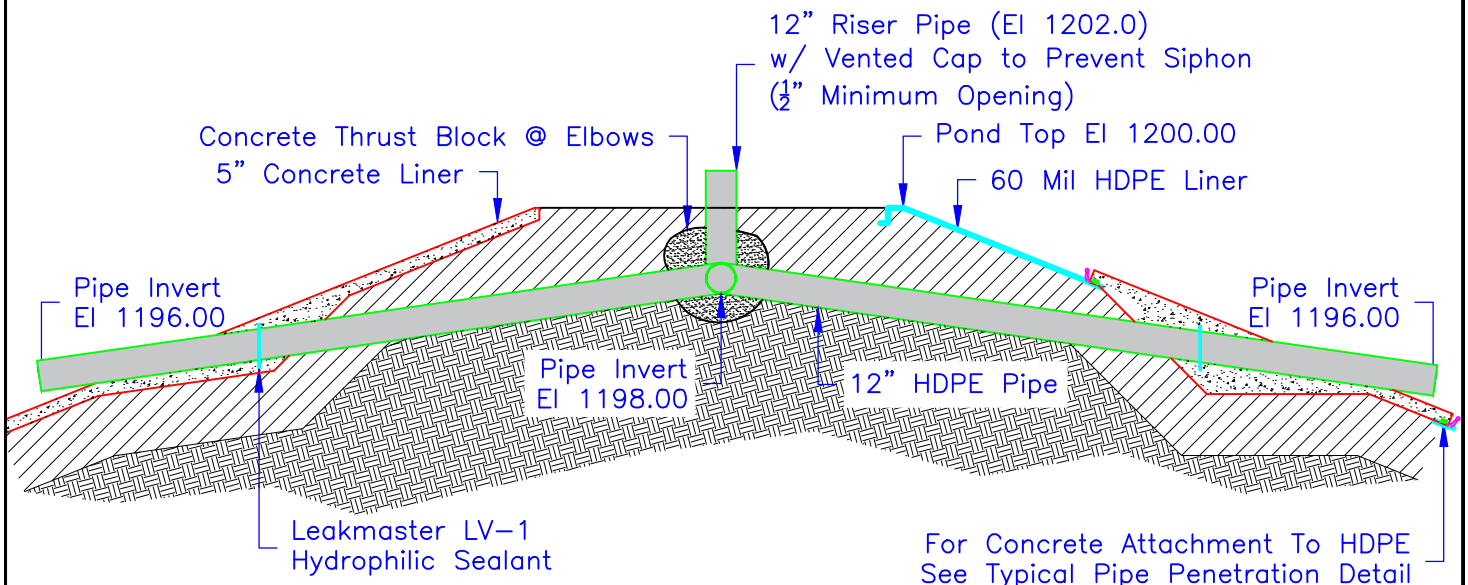
Cross Section D-D Shows The Crossover Channel Between Pond 1 & Pond 2. The Top of The Footing Shall Be Level At El 1196.0. The Wall Height Shall Vary At Pond 1 and Pond 2 and Shall Taper As Appropriate At The Pond So That The 5" Concrete Pond Side Slope Concrete Flatwork Can Be Placed On Top of The Walls. The HDPE Liner Shall Be Attached To The Concrete Top Slab With Embedment Strips. Vertical Wall Seal and Longitudinal Footing Steel Shall Extend Into Pond Concrete Flatwork. The Joints Between The Footing And The Walls Shall Be Sealed with Leakmaster LV-1 Hydrophilic Sealant.



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Concrete Crossover Channel Section D-D Emerald Sky Dairy, LLC	Dwg: H17-3 8/10/2017



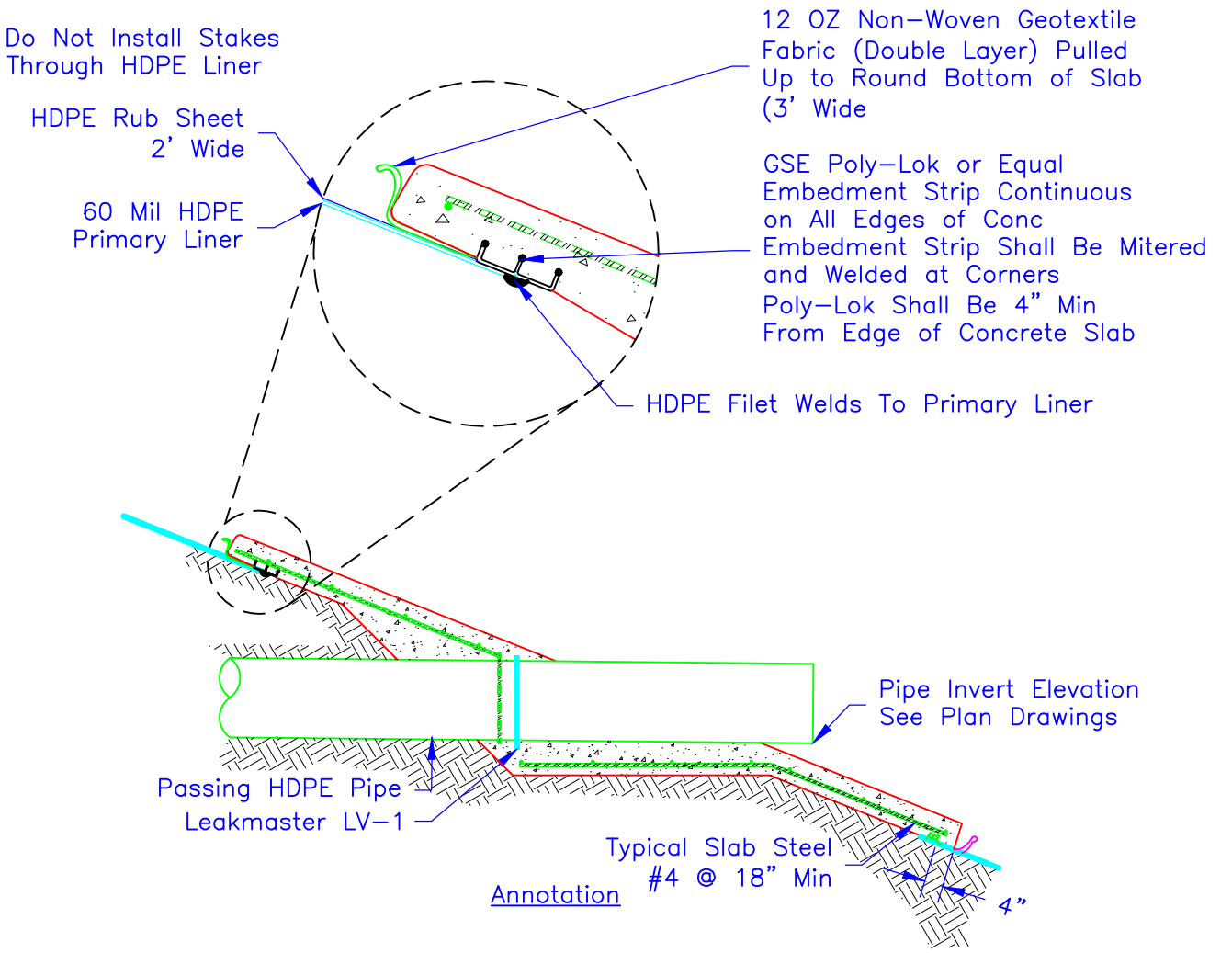
Plan View

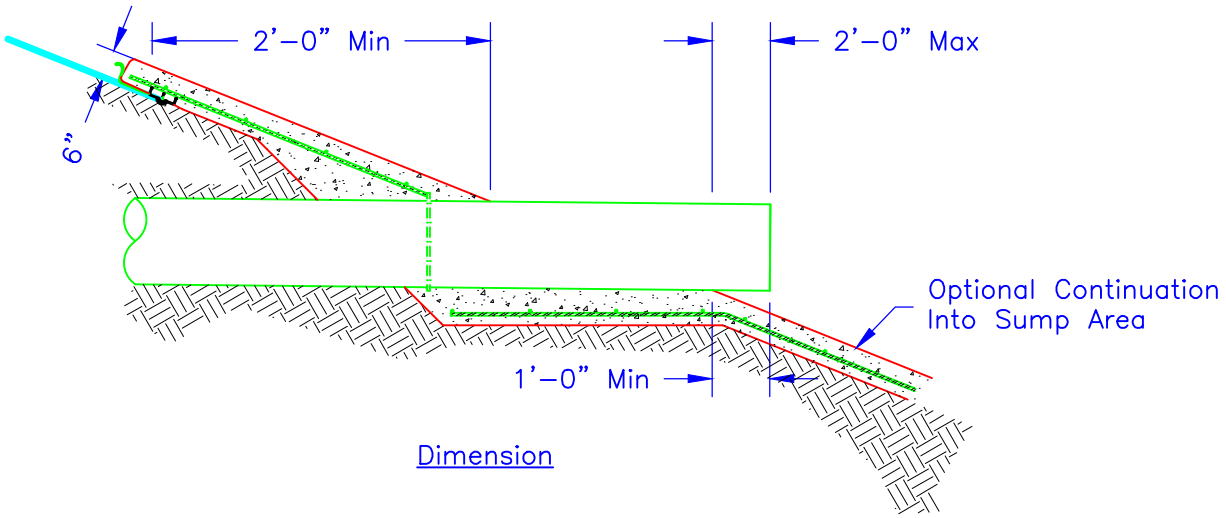


Section View

Cross Over Pipe Shall Be 12" Dual Wall HDPE Pipe ADS N-12 or Equal With WT Gaskets At All Joints and Elbows

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Example Crossover Pipe (WSF Stage 1 to Stage 2) Emerald Sky Dairy, LLC	Dwg: B5 8/10/2017





WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Pipe Penetration Into HDPE Lined Waste Storage Facility Emerald Sky Dairy, LLC	Dwg: G7 8/10/2017

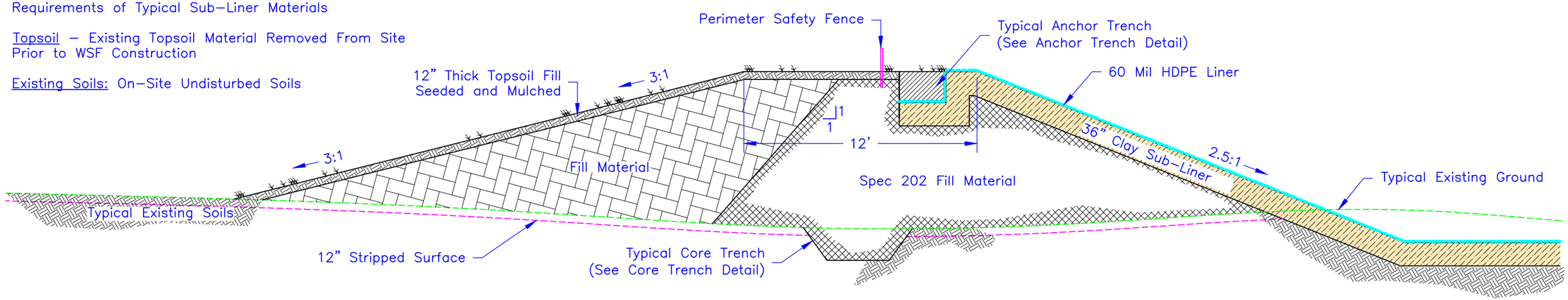
Minimum Required Sub–Liner – (Placed Directly Below HDPE Pond Liner) – ≥ 40% Fines, PI ≥ 7, ≥ 2ft of Thickness (In Accordance with WI Spec 204 and WI Spec 202 or 205) *An Additional 12" of Clay Sub–liner Shall Be Added to HDPE And Concrete Ponds

Fill Material – On–Site Soils That Do Not Meet The Requirements of Typical Sub–Liner Materials

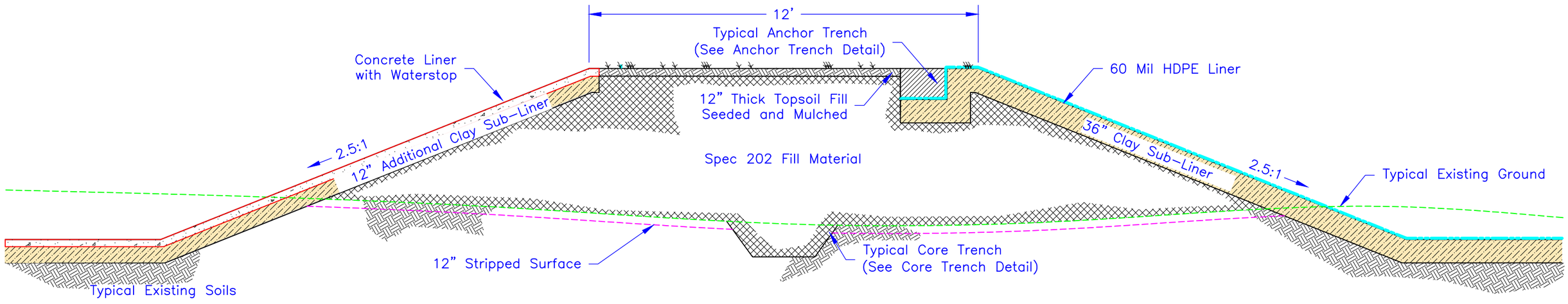
Topsoil – Existing Topsoil Material Removed From Site Prior to WSF Construction

Existing Soils: On–Site Undisturbed Soils

Soils to be Tested and Approved For Use by Williams Engineering Services, LLC

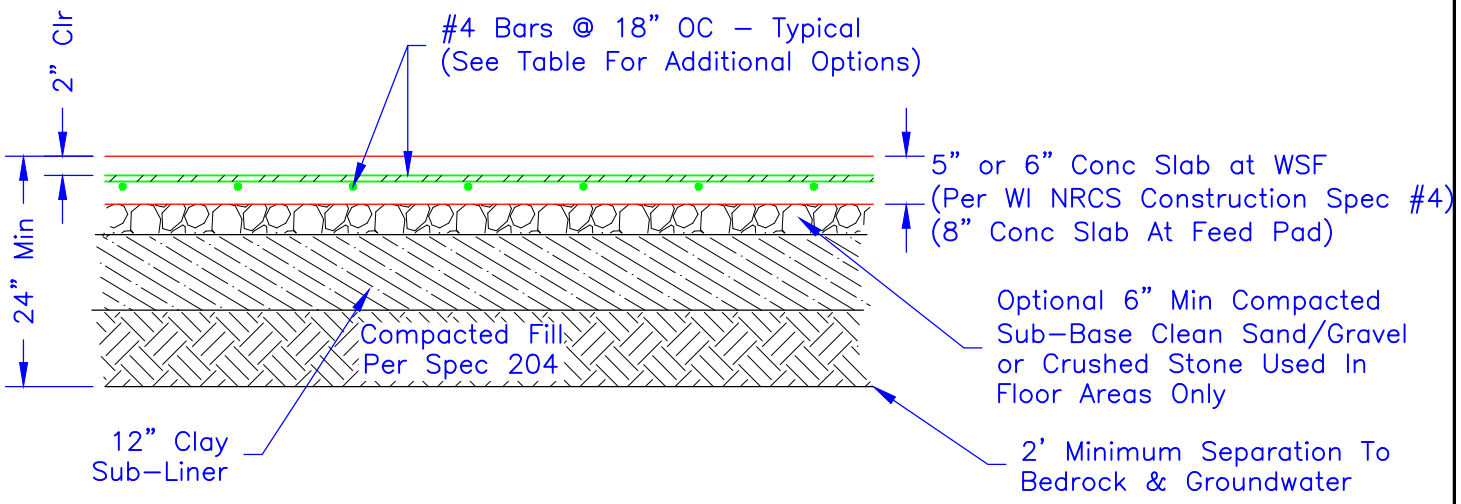


Typical Exterior Embankment



Typical Interior Embankment

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Typical Embankment Sections Emerald Sky Dairy, LLC	Dwg: J18 8/10/2017



Note: Reinforcing Steel For 8" Feed Pad Concrete Must Follow These Minimum Requirements:

≤ 100 Ft Joint Spacing Use #6 Rebar @ 18" OC
≤ 150 Ft Joint Spacing Use #6 Rebar @ 15" OC
≤ 175 Ft Joint Spacing Use #6 Rebar @ 12" OC

Typical Section

General Construction Notes:

1. Concrete is to Be Mixed and Place According to WI NRCS Construction Spec #4
2. Joints Are to Be Spaced as Specified in Plan Sheets
3. White Curing Compound (ASTM C–309, Type 2) Shall Be Applied to Concrete as Soon as The Concrete Can Be Walked on, And Within 24 Hours of Concrete Placement
4. Site Preparation: Remove All Organic and Un–Compacted Material Before Placing Sand/Gravel Sub–Base or Clay Sub–Liner
5. Any Ramps Shall Have a Roughened Traction Surface. Other Areas Floated/Finished to "Close" Finished Surface
6. Steel Shall Be Chaired/Bricked (2" MIN Cover From Sub–Grade)

To Be Used in Conjunction
With PVC Waterstop and Dowel Pins/Keyways
to Make Liquid Tight Structure

Concrete Slab
(5" Slab – 1.55 CU YD Per 100 SQ FT)
(6" Slab – 1.85 CU YD Per 100 SQ FT)
(8" Slab – 2.48 CU YD Per 100 SQ FT)

White Curing Compound (ASTM C–309, Type 2) Shall Be Applied Per Manufacturer's Recommendation In Order To Seal Concrete Surfaces

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Concrete Slab Detail (Waste Storage Facility & Feedpad) Emerald Sky Dairy, LLC	Dwg: B2 8/10/2017

WSF CONCRETE SLAB SCHEDULE

SLAB THICKNESS	STEEL SCHEDULE (E.W.)	MAXIMUM JOINT SPACING	SUBGRADE SOILS IN CONTACT WITH SLAB
5" (6")	DEFORMED BARS #4 @ 18" O.C. GRADE 60	87 FT* (73 FT)*	SILTY
5" (6")	DEFORMED BARS #4 @ 18" O.C. GRADE 60	100 FT (97 FT)*	GRANULAR (GRAVEL OR SAND/GRAVEL)
5" (6")	DEFORMED BARS #4 @ 15" O.C. GRADE 60	105 FT** (87 FT)	SILTY
5" (6")	DEFORMED BARS #4 @ 15" O.C. GRADE 60	140 FT** (117 FT)	GRANULAR (GRAVEL OR SAND/GRAVEL)
5" (6")	DEFORMED BARS #4 @ 12" O.C. GRADE 60	131 FT** (109 FT)	Silty
5" (6")	DEFORMED BARS #4 @ 12" O.C. GRADE 60	175 FT*** (146 FT)**	GRANULAR (GRAVEL OR SAND/GRAVEL)
5" (6")	DEFORMED BARS #5 @ 18" O.C. GRADE 60	137 FT** (114 FT)**	Silty
5" (6")	DEFORMED BARS #5 @ 18" O.C. GRADE 60	175 FT*** (150 FT)**	GRANULAR (GRAVEL OR SAND/GRAVEL)

* Value Is More Conservative Than NRCS 313 Table A Value of 100 Feet (1/14)
** Value Is More Conservative Than NRCS 313 Table A Value of 150 Feet (1/14)
*** Value Is More Conservative Than NRCS 313 Table A Value of 175 Feet (1/14)
In Accordance With WI NRCS Construction Specification #4 (1/14)

Reinforcement Steel Overlap Requirement Per WI Construction Spec #4 (6/16): (Slabs and Walls)***
#4 BAR – LAP = 21"
#5 BAR – LAP = 26"
#6 BAR – LAP = 31"

NOTE:
Silty = Typically on Site Native Silt Soils or Clay Sub–Liner Material Placed Directly Under Concrete.
> 20% Fines (P200) Such as on Side Slopes For Stability of Soils or Where Bedrock Has Been Removed (No Bedrock Expected)

Granular = Typically on Site Sand > 20% Fines (P200)

WSF Slab Shall Be 6" Thick In Traffic Areas

WES
PROFESSIONAL ENGINEERING

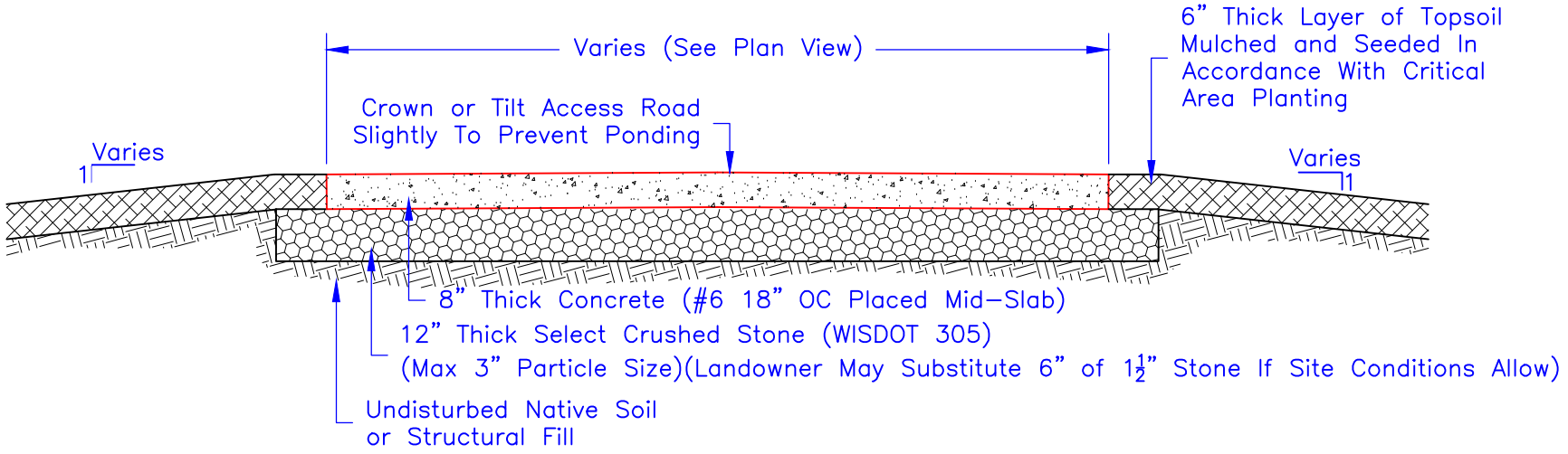
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

Concrete Slab Chart
(Waste Storage Facility)

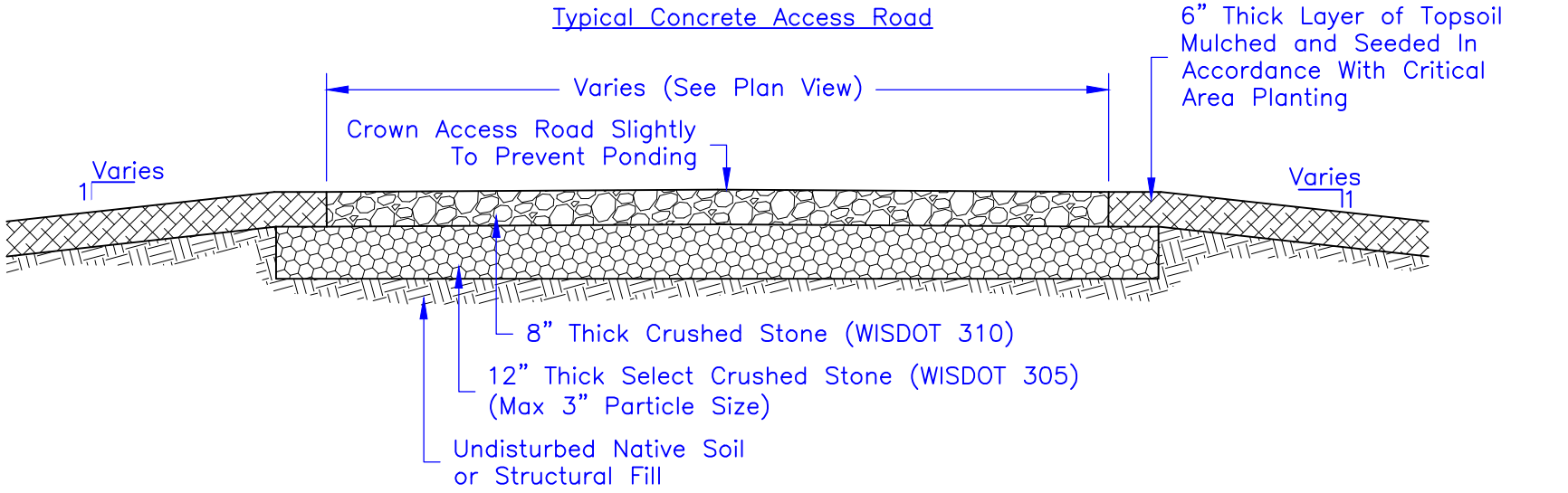
Emerald Sky Dairy, LLC

Dwg: B1

8/10/2017



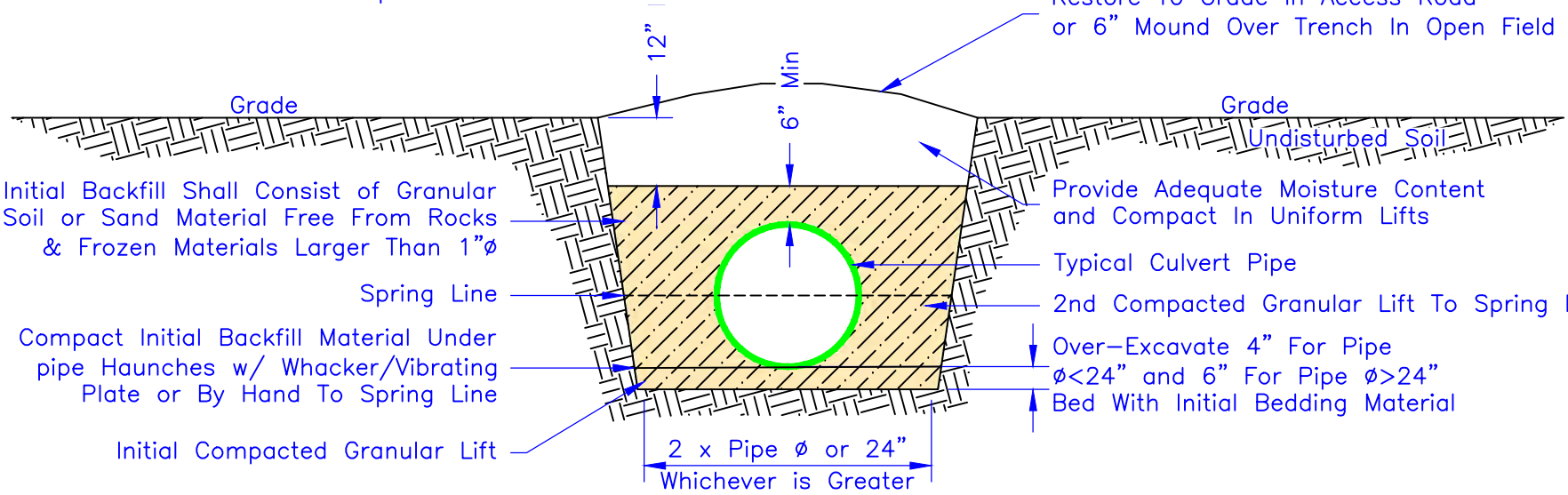
Typical Concrete Access Road



Typical Gravel Access Road

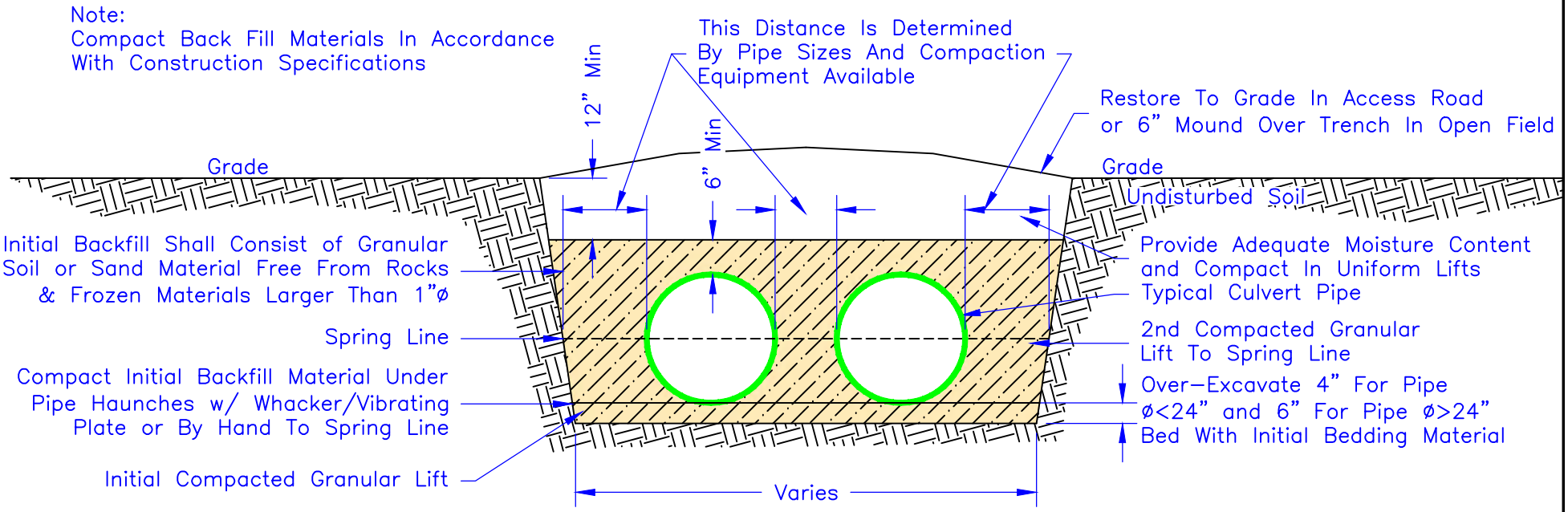
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Typical Access Road Emerald Sky Dairy, LLC	Dwg: E10 8/10/2017

Note:
Compact Back Fill Materials In Accordance With Construction Specifications



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Culvert Trench Section In Access Road or Open Field Emerald Sky Dairy, LLC	Dwg: E11 8/10/2017

Note:
Compact Back Fill Materials In Accordance With Construction Specifications

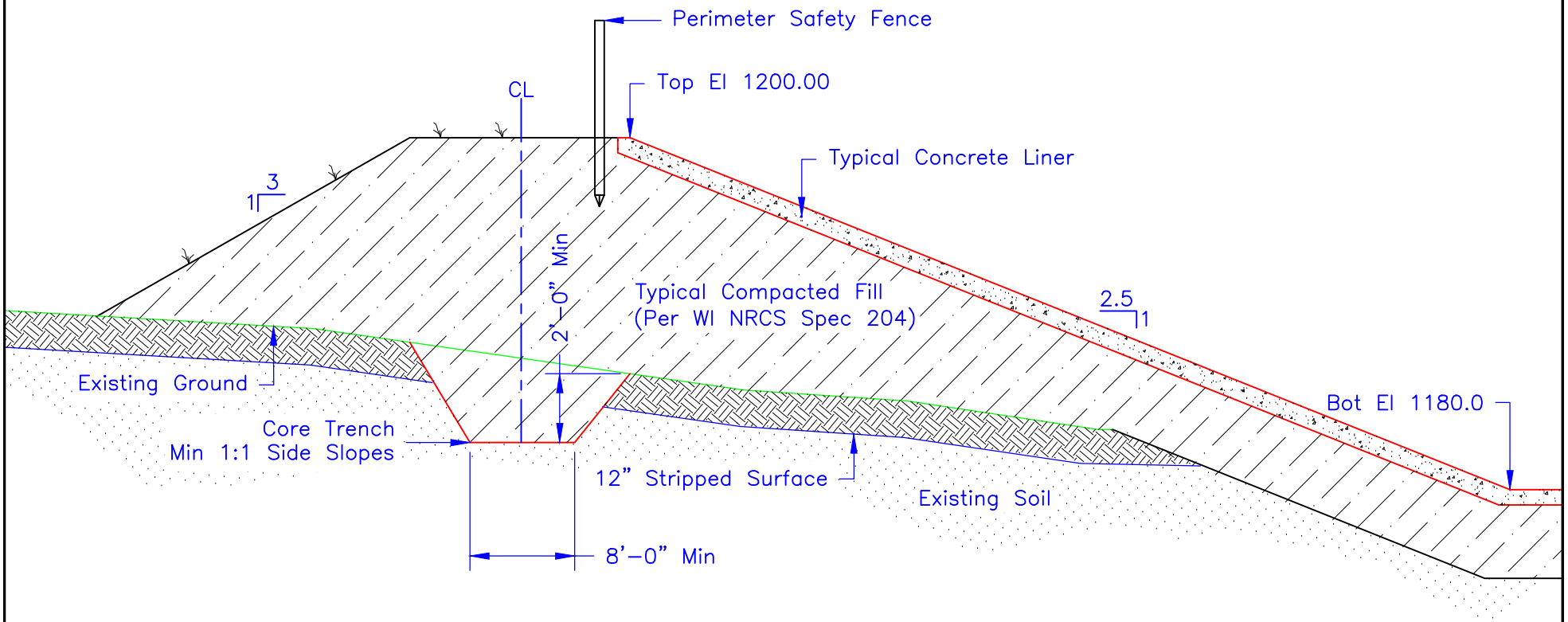


WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Multiple Culvert Trench Section In Access Road or Open Field Emerald Sky Dairy, LLC	Dwg: E8 8/10/2017

Embankment Requirements:

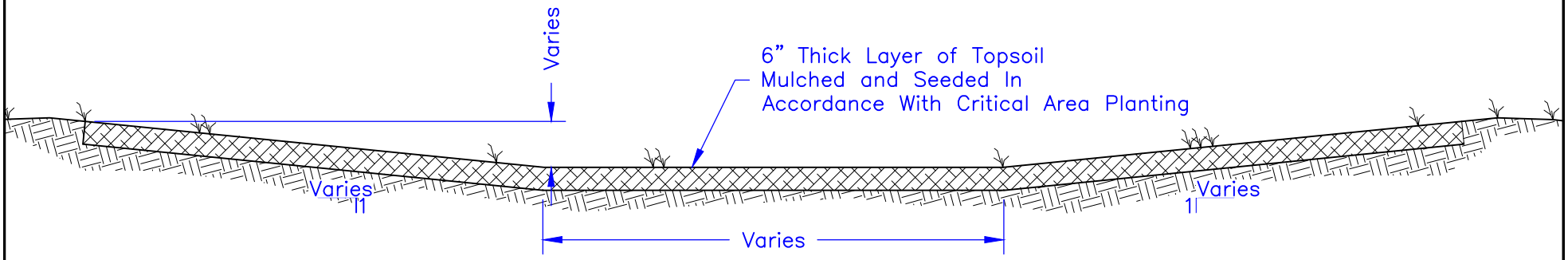
- A Core Trench Is Required Whenever The Settled Embankment Fill Height At The Centerline Is Greater Than or Equal to 10.0'
- Minimum Top Width Shall Be According To The Table
- The Sum of The Interior & Exterior Side Slopes Shall Be Greater Than or Equal to 5:1 With Exterior Embankment Slope No Steeper Than 2:1
- Compaction Shall Be According to WI NRCS Construction Specification 204, Earthfill For Waste Storage Facilities (Spec 204)

Settled Embankment Fill Height (Feet)	Required Min Top Width (Feet)
0–10	≥8
10.1–15	≥10
15.1–20	≥15
20.1–25	≥20



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Typical Core Trench Emerald Sky Dairy, LLC	Dwg: F11 8/10/2017

Note:
1. Side Slopes of Trapezoidal Swale As Noted On Plan View
2. Bottom Width of Trapezoidal Swale As Noted On Plan View
3. Depth of Trapezoidal Swale As Noted On Plan View



WES
PROFESSIONAL ENGINEERING

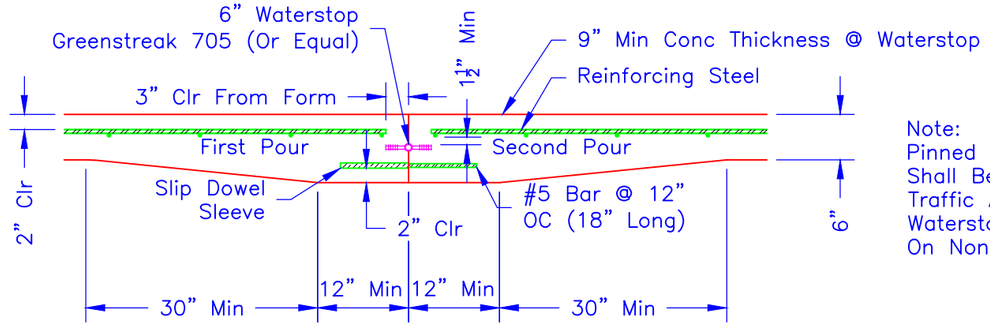
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Trapezoidal Shaped Grassed Waterway/Swale

Emerald Sky Dairy, LLC

Dwg: E12

8/10/2017



Note:
Pinned Waterstop Joints Shall Be Used On All Traffic Areas. Keyway Waterstops May Be Used On Non–Traffic Areas

NOTE: The Slab Thickness At The Joint Must Be Equal To, or Greater Than 9"

Installation:

A. Position The Waterstop and Dowel As Shown In This Drawing.
B. Secure The Waterstop Along Its Length At The Center Bulb and Sufficiently At The Web To Hold It In Place.
C. Follow The Manufacturers Recommendations To Install The Dowel and Sleeve.
D. Place Concrete Without Displacing The Waterstop. Waterstop May Be Tack Nailed To Form Work At Outside Rib
E. Thoroughly Vibrate Concrete Around The Waterstop To Prevent Voids.
F. After The First Pour, Clean The Un–Embedded Waterstop Web To Insure Full Contact with the second pour of concrete.
G. Installation Methods Shall Be In Strict Compliance With The Manufacturer's Requirements.

Specifications:

A. Work Consists Of Providing Flexible Waterstops, Embedded In Concrete, At Control And/Or Construction Joints.
B. Waterstop Must Form A Continuous Seal Throughout The Structure.
C. Waterstop Is To Be Manufactured PVC, Thermoplastic Elastomeric Rubber, (TPE), Or Polyethylene P.E. Material With A Minimum Web Thickness Of $\frac{3}{16}$".
D. Waterstop Is To Be Free Of Dirt, Oil, and Defects.
E. Reinforcing Steel Shall Not Pass Through Control Joints.

Splice Fabrication:

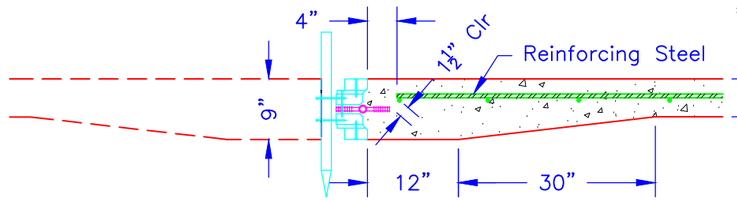
A. Provide Pre–Fabricated Waterstop Corners And Transitions Leaving Only Straight Butt Joint Splices For Field Fabrication, Unless Specifically Approved By The Engineer. Welds Must Be Performed In Accordance With Manufacture's Specifications.
B. Use Only A Splicing Iron Specifically Recommended By The Manufacturer For Heat Fused Welding Of All Splices.
C. Welds Are To Exhibit A Continuous Bead Of Excess Melted Material, Free Of Defects.
D. Splices Are To Be Heat Welded With The Center Bulb And Ribs Aligned.
E. Adhesives, Solvents, Lap Joints, And Edge Welding Are Not Acceptable.
F. Embedded Waterstops May Not Be Welded Or Joined To Other Waterstops Of Different Size, Configuration, or Material.

Note: Concrete Pond Floor Area and Ramp Shall Be 6" Thick.

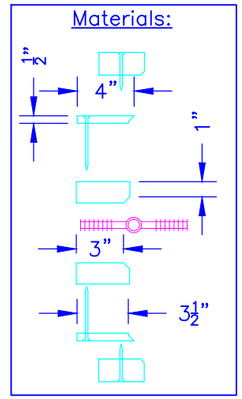
Note: Vibration Of Concrete Around Waterstop Is Essential

Waterstop With Poorly Consolidated Concrete Shall Be Removed and Replaced Under The Direction Of The Engineer.

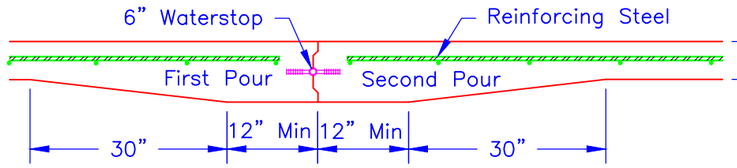
Typical Slab Keyway Waterstop Cross Section
(Showing Forms)



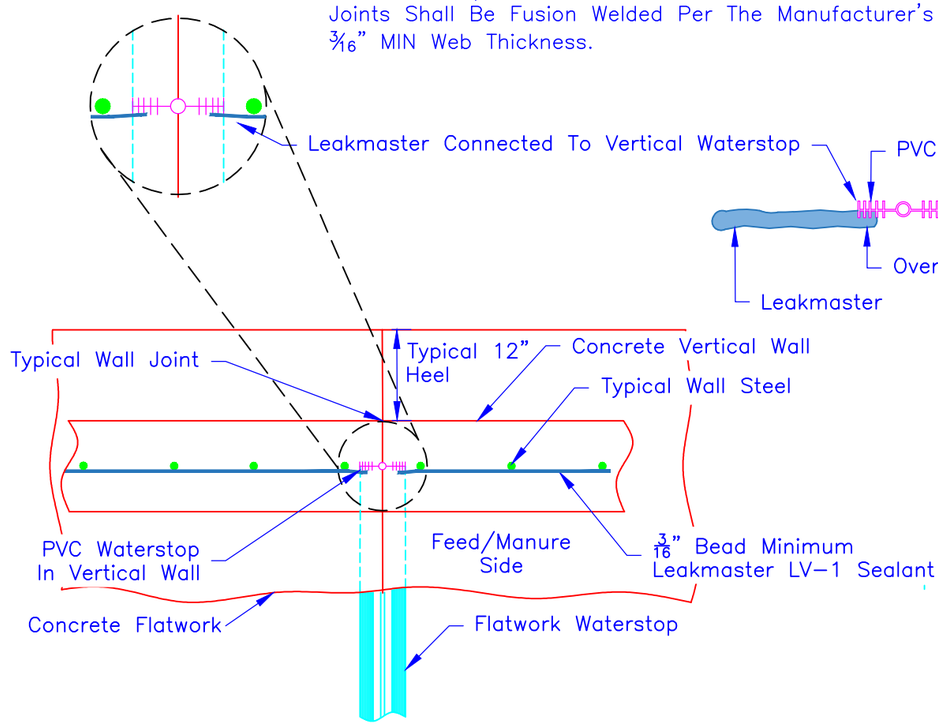
Materials:



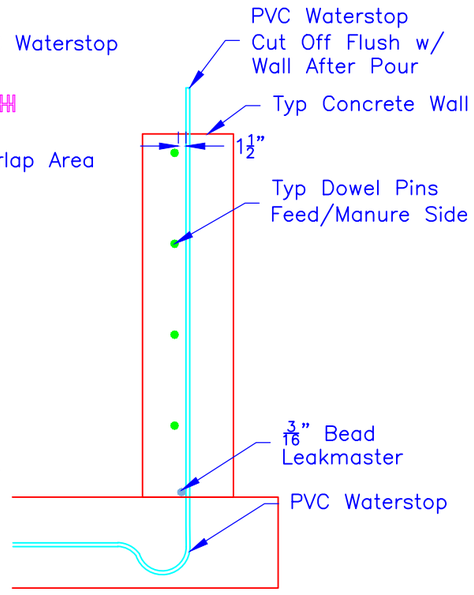
Cross Section After Forms Are Removed



Note:
PVC Waterstop Shall Be Ribbed With Centerbulb Following Const Spec 4. Joints Shall Be Fusion Welded Per The Manufacturer's Recommendations. $\frac{3}{16}$" MIN Web Thickness.

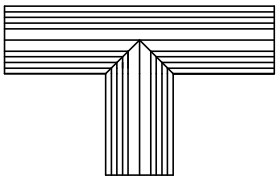


Plan View of Waterstop @ Vertical Wall

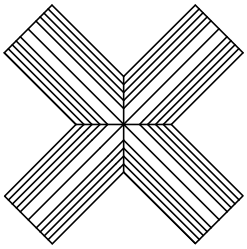


Waterstop @ Top of Vertical Wall

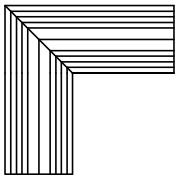
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Typical Waterstop Details Emerald Sky Dairy, LLC	Dwg: C1 8/10/2017



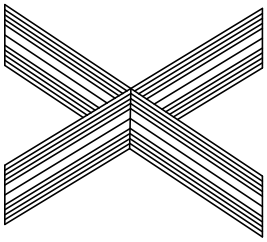
Flat Tee



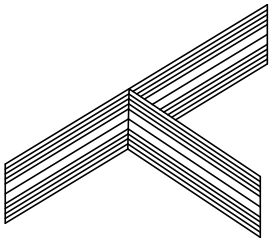
Flat Cross



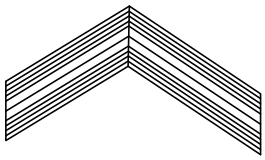
Flat Ell



Vertical Cross



Vertical Tee



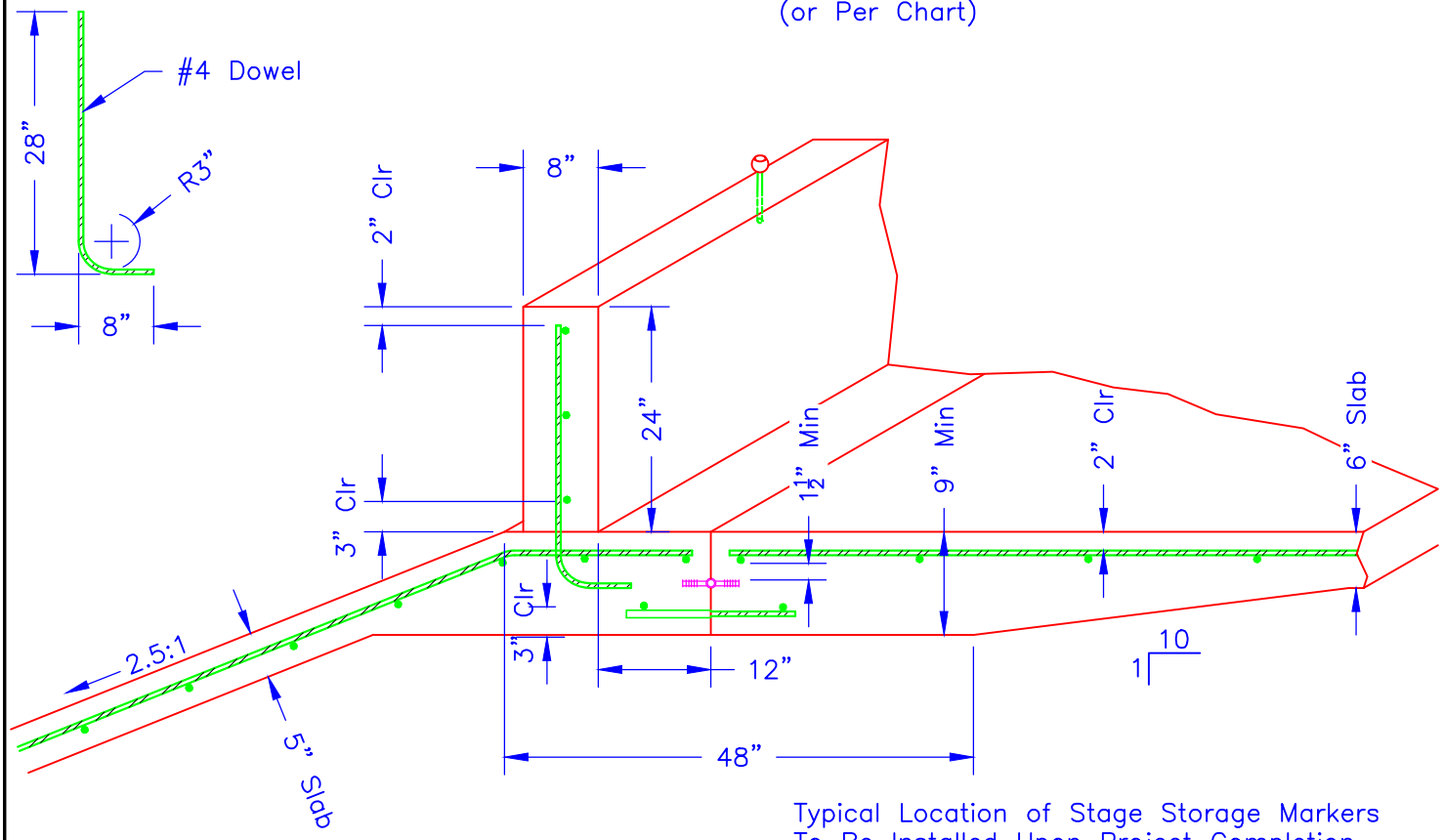
Vertical Ell

Notes:

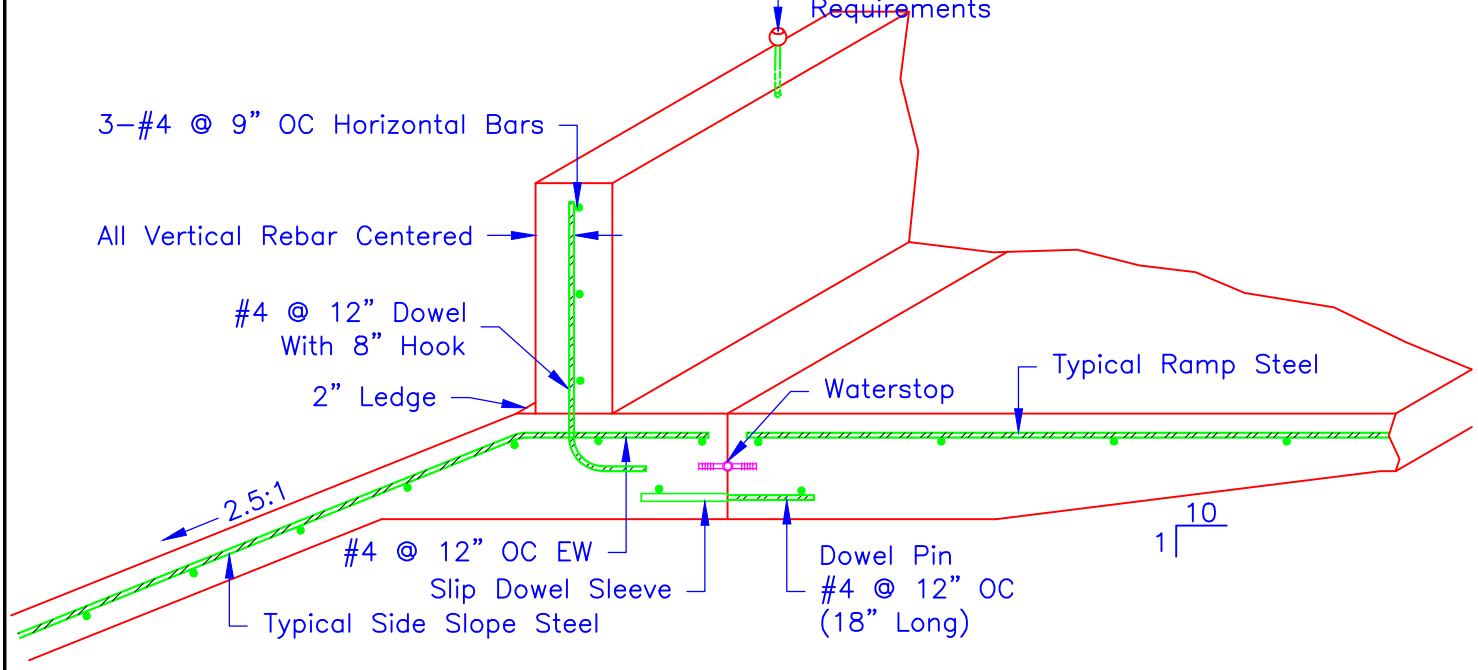
1. Provide Factory Welded Waterstop Intersections As Shown
2. Waterstop Is To Be Manufactured PVC, TPE, Or PE, With A Minimum Web Thickness Of 3/16".
3. Embedded Waterstops May Not Be Welded Or Joined To Other Waterstops Of Different Size, Configuration, Or Material.
4. Waterstop Shall Be Installed In Accordance With WI NRCS Construction Spec #4

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	6" Embedded Waterstop Factory Intersections Examples Emerald Sky Dairy, LLC	Dwg: C5 8/10/2017

NOTE: Slab Steel Shall Be #4 Bars @ 18" OC EW
(or Per Chart)



Typical Location of Stage Storage Markers
To Be Installed Upon Project Completion
By Engineer Based on As-Built Volume
Calculations In Accordance with NR243
Requirements



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	2 Foot Safety Wall Along Pond Ramp Emerald Sky Dairy, LLC	Dwg: F1 8/10/2017

NOTE: See 4 Foot Wall Annotation Sheet For Further Detail

CONDITIONS OF USE

BACKFILL: 0 TO 4' 0 – <50% Fines

ASSUMED LOADING CONDITIONS:
2' Additional Backfill, Saturated Soil

REBAR: Grade 60

CONCRETE: 4000 PSI Per WI NRCS Spec #4

NOTE:
Calf Hutch Slab Shall Be 6" Thick and Steel Shall Be #4 Bars @ 18" OC EW (or Per Chart)

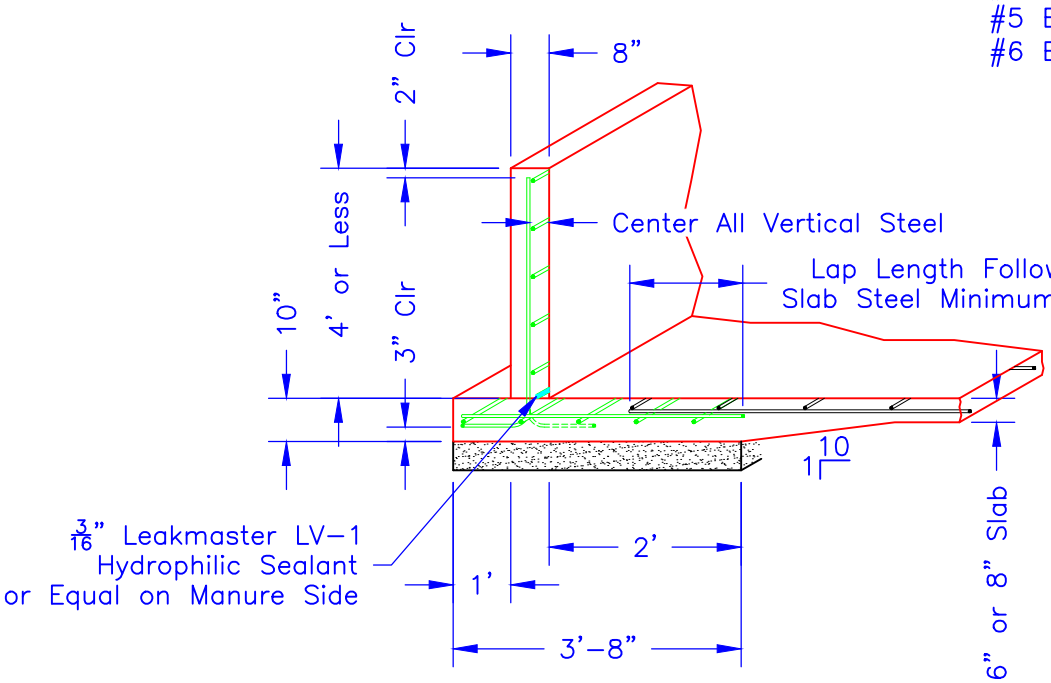
Feedpad Slab Shall be 8" Thick and Steel Shall be #6 Bars @ 18" OC EW (or Per Chart)

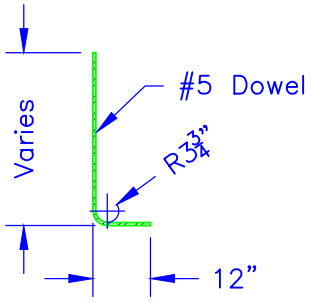
NOTE:
Wall Form Ties Shall Break Back A Min of $\frac{1}{2}$" Below Wall Surface On Both Sides of Wall And Shall Be Sealed With Unitex Pro–Poxy Epoxy or Equal Prior To Application of White Pigmented Curing Compound

This Wall Design Shall Be Used For:

- Upper Feedpad Collection Tank
- Lower Feedpad Wall Adjacent to HDPE Lined Pond and Perimeter Walls
- Calf Hutch Area Perimeter Walls
- Channel to the TMF Manure Storage Tank
- Solids Stacking Area
- Additional Walls 4' And Shorter

Steel Bar Lap:
#4 Bars – 21" Lap
#5 Bars – 26" Lap
#6 Bars – 31" Lap





WALL SECTION
(Footing Shall Be Liquid Tight to Concrete Basin Floor. Leakmaster LV–1 Shall Be Used on Manure/Feed Side)

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	0–4 Foot Walls (Dimensions) Emerald Sky Dairy, LLC	Dwg: F4 8/10/2017

NOTE: See 4 Foot Wall Annotation Sheet For Further Detail

CONDITIONS OF USE

BACKFILL: 0 TO 4' 0 – <50% Fines

ASSUMED LOADING CONDITIONS:
2' Additional Backfill, Saturated Soil

REBAR: Grade 60

CONCRETE: 4000 PSI Per WI NRCS Spec #4

NOTE:
Calf Hutch Slab Shall Be 6" Thick and Steel Shall Be #4 Bars @ 18" OC EW (or Per Chart)

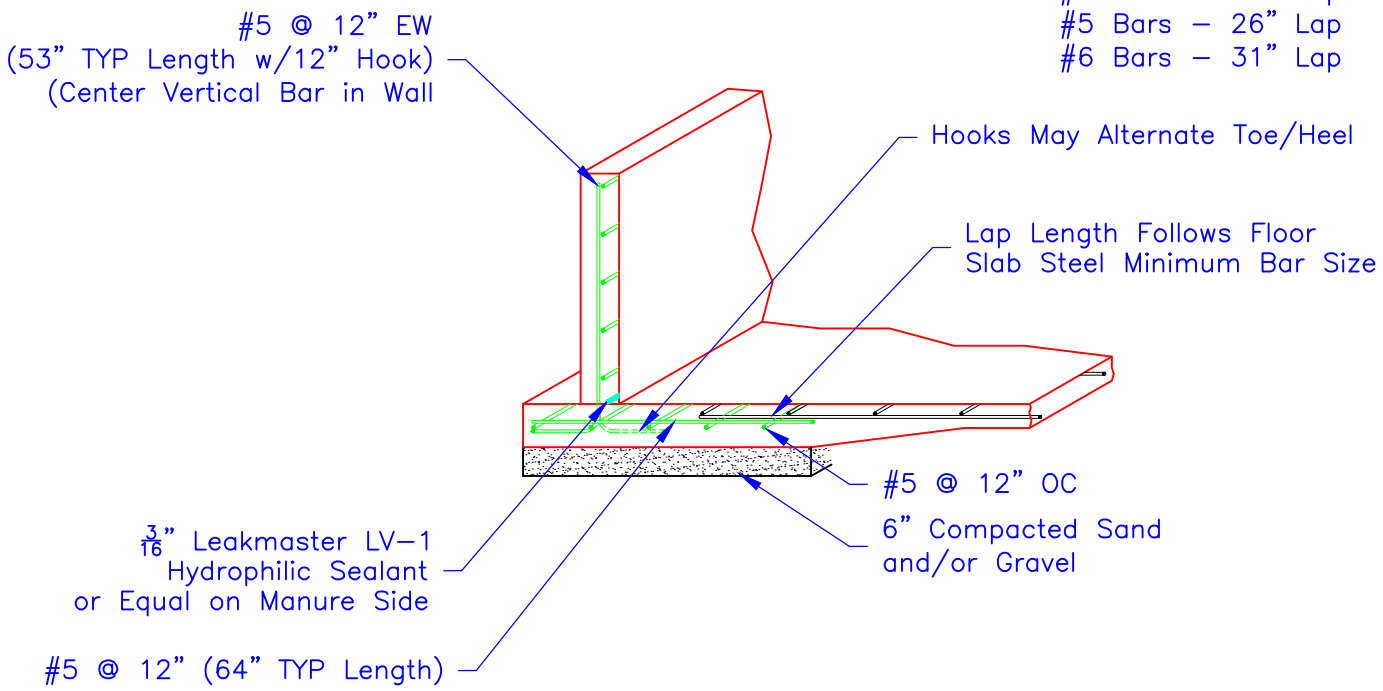
Feedpad Slab Shall be 8" Thick and Steel Shall be #6 Bars @ 18" OC EW (or Per Chart)

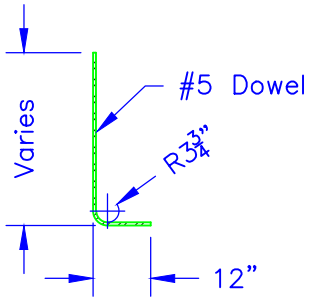
NOTE:
Wall Form Ties Shall Break Back A Min of $\frac{1}{2}$" Below Wall Surface On Both Sides of Wall And Shall Be Sealed With Unitex Pro–Poxy Epoxy or Equal Prior To Application of White Pigmented Curing Compound

This Wall Design Shall Be Used For:

- Upper Feedpad Collection Tank
- Lower Feedpad Wall Adjacent to HDPE Lined Pond and Perimeter Walls
- Calf Hutch Area Perimeter Walls
- Channel to the TMF Manure Storage Tank
- Solids Stacking Area
- Additional Walls 4' And Shorter

Steel Bar Lap:
#4 Bars – 21" Lap
#5 Bars – 26" Lap
#6 Bars – 31" Lap





WALL SECTION
(Footing Shall Be Liquid Tight to Concrete Basin Floor. Leakmaster LV–1 Shall Be Used on Manure/Feed Side)

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	0–4 Foot Walls (Annotations) Emerald Sky Dairy, LLC	Dwg: F4–1 8/10/2017

NOTE: See 6 Foot Wall Annotation Sheet For Further Detail

NOTE:
Calf Hutch Slab Shall Be 6" Thick and Steel Shall Be #4 Bars @ 18" OC EW (Or Per Chart)

Feedpad Slab Shall be 8" Thick and Steel Shall be #6 Bars @ 18" OC EW (or Per Chart)

NOTE:
Wall Form Ties Shall Break Back A Min of ½" Below Wall Surface On Both Sides of Wall And Shall Be Sealed With Unitex Pro–Poxy Epoxy or Equal Prior To Application of White Pigmented Curing Compound

CONDITIONS OF USE

BACKFILL: 0 TO 6' 0 – <50% Fines

ASSUMED LOADING CONDITIONS:
2' Additional Backfill, Saturated Soil

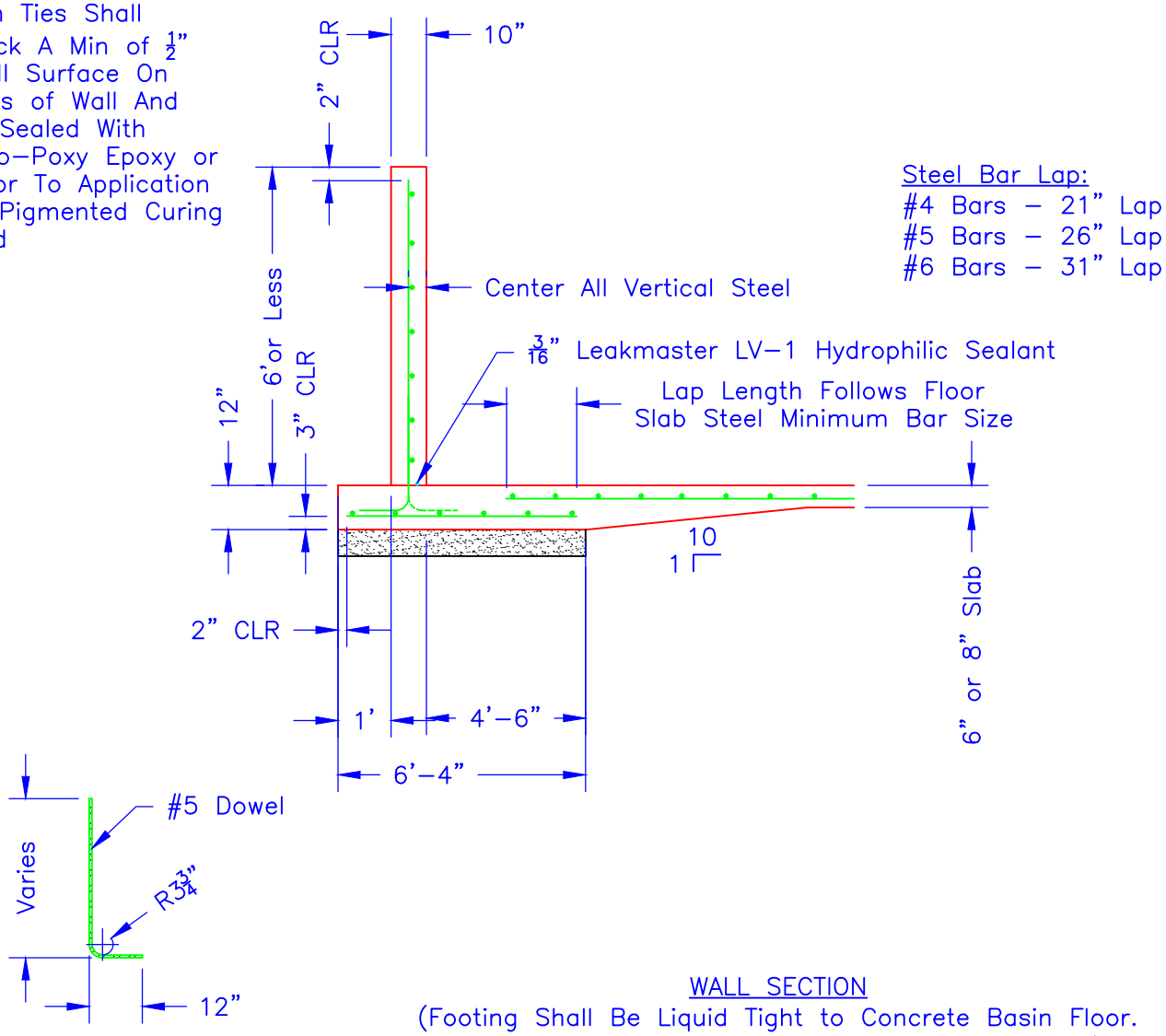
REBAR: Grade 60

CONCRETE: 4000 PSI Per WI NRCS Spec #4

This Wall Design Shall Be Used For:

- Heifer Lot Collection Tank
- Additional Walls Over 4 to 6 Feet Tall

Steel Bar Lap:
#4 Bars – 21" Lap
#5 Bars – 26" Lap
#6 Bars – 31" Lap



WALL SECTION
(Footing Shall Be Liquid Tight to Concrete Basin Floor. Leakmaster LV–1 Shall Be Used on Manure Side)

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	6 Foot Wall (Dimensions) Emerald Sky Dairy, LLC	Dwg: G2 8/10/2017

NOTE: See 6 Foot Wall Annotation Sheet For Further Detail

NOTE:
Calf Hutch Slab Shall Be 6" Thick and Steel Shall Be #4 Bars @ 18" OC EW (Or Per Chart)

Feedpad Slab Shall be 8" Thick and Steel Shall be #6 Bars @ 18" OC EW (or Per Chart)

NOTE:
Wall Form Ties Shall Break Back A Min of $\frac{1}{2}$" Below Wall Surface On Both Sides of Wall And Shall Be Sealed With Unitex Pro-Poxy Epoxy or Equal Prior To Application of White Pigmented Curing Compound

CONDITIONS OF USE

BACKFILL: 0 TO 6' 0 - <50% Fines

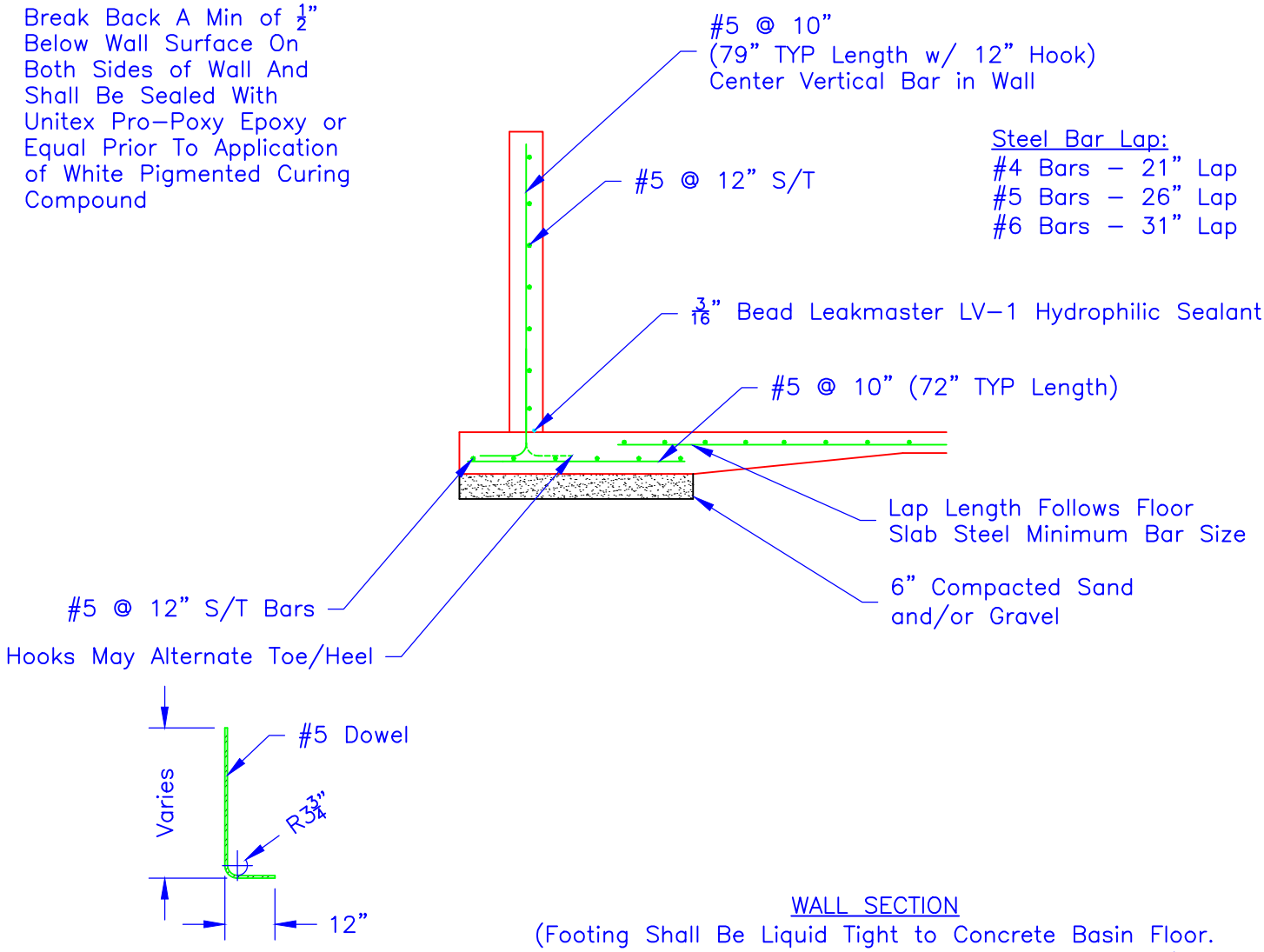
ASSUMED LOADING CONDITIONS:
2' Additional Backfill, Saturated Soil

REBAR: Grade 60

CONCRETE: 4000 PSI Per WI NRCS Spec #4

This Wall Design Shall Be Used For:

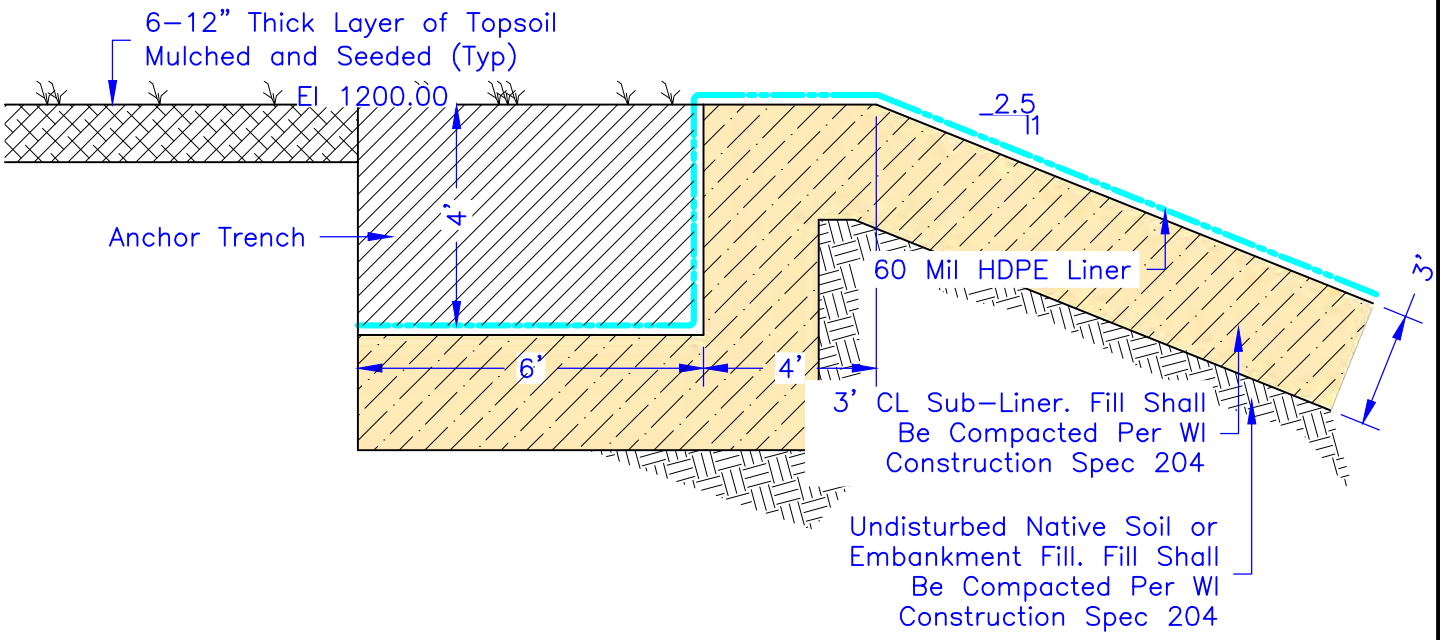
- Heifer Lot Collection Tank
- Additional Walls Over 4 to 6 Feet Tall



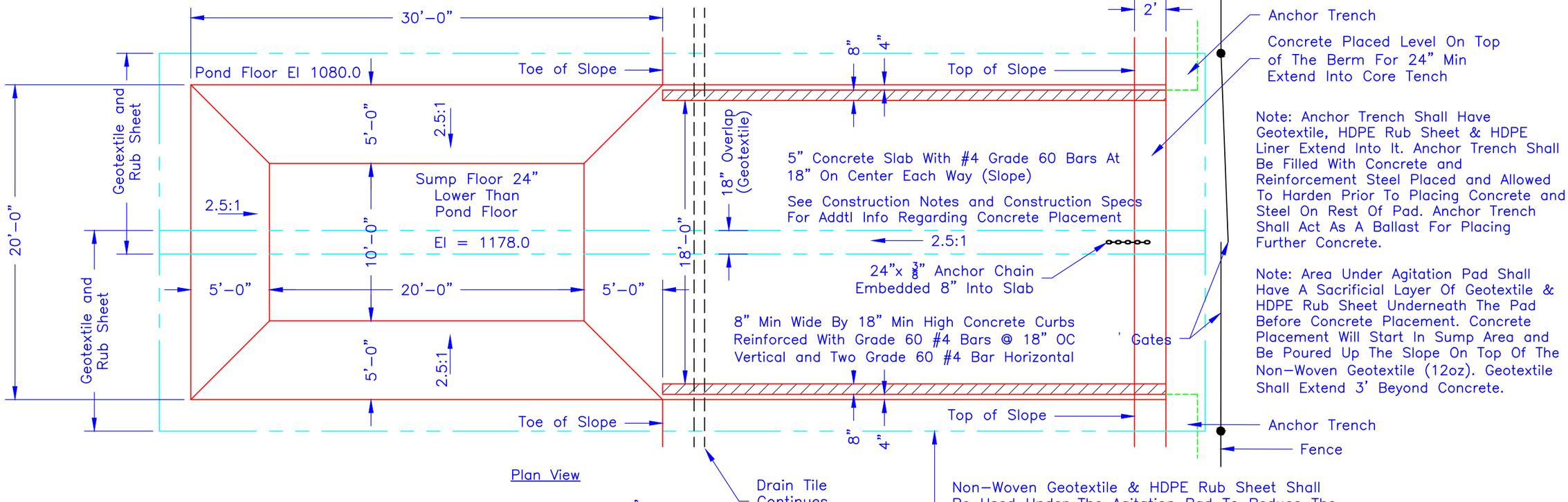
WALL SECTION
(Footing Shall Be Liquid Tight to Concrete Basin Floor. Leakmaster LV-1 Shall Be Used on Manure Side)

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	6 Foot Wall (Annotations) Emerald Sky Dairy, LLC	Dwg: G2-1 8/10/2017

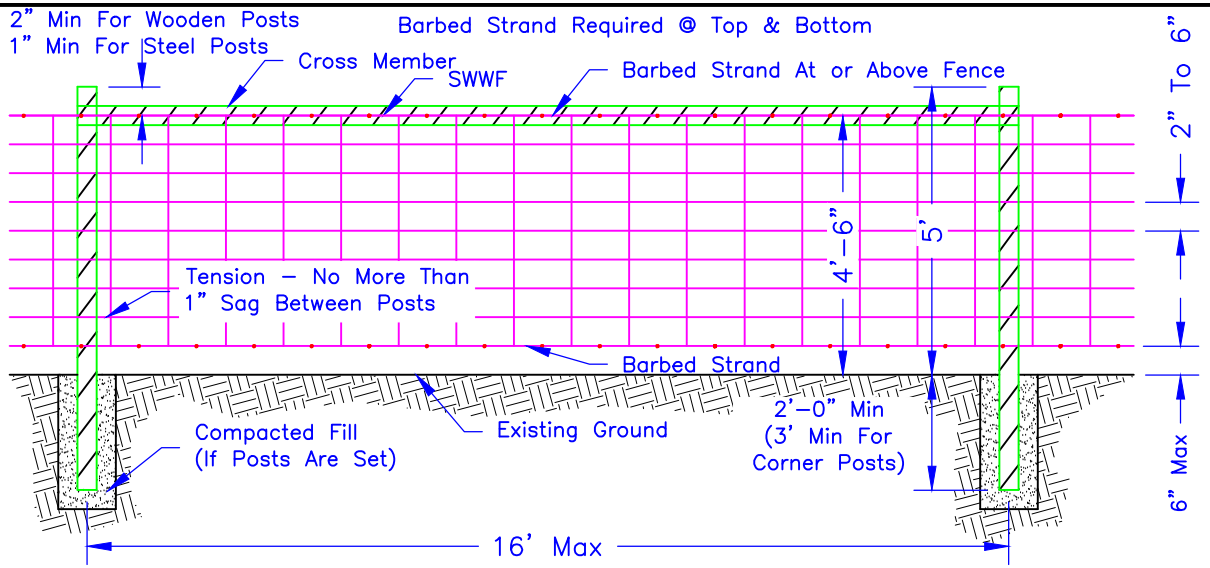
Note:
Anchor Trench Dimensions Typical
For 2nd Stage HDPE Pond



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	HDPE Liner/ Trench (Example Only) Emerald Sky Dairy, LLC	Dwg: J14 8/10/2017



WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715–829–3231	Typical Agitation Pad for HDPE Pond Emerald Sky Dairy, LLC	Dwg: M14–1 8/10/2017



Steel Line Posts Shall Be Set Or Driven A Min Of 18" Below Ground Line

If Posts Are Not Driven, The Backfill Around The Post Shall Be Well Compacted

Notes:
Standard Woven Wire Fence (SWWF) Shall Consist Of Woven Wire With Single Or Multiple Strands Of Either Barbed Wire Or High Tensile Smooth Wire With A Min Spacing Of 2" To 6" Starting At The Top Of The Woven Wire

Wire:
SWWF Shall Be Made From Low-Carbon Steel Wire With Class 3 Galvanizing Meeting ASTM A 641. The Woven Wire Shall Have The Top And Bottom Strands 10-Gauge or Heavier. Intermediate And Stay Wires Shall Be 14.5-Gauge or Heavier. The Stay Wires Shall Be Spaced A Max 6" Apart For Safety Fences

Tensile Strength – 140,000 PSI (Min)
Breaking Strength – 900 LBS (Min)

Fasteners:
Staples Shall Be 9-Gauge, Class 3 Galvanized Steel or Heavier With A Min Length Of 1.75" For Softwoods And A Min 1" For Close-Grained Hardwoods

Manufacturer's Clips or 14-Gauge, Class 3 Galvanized Wire May Be Used To Fasten Wires To Steel Posts

Note:
Fences Using Entirely Wood Posts Shall Be Grounded For Lightening Protection At Least Every Quarter Mile With Ground Rods Driven Not Less Than 4' Into The Ground

Posts:
Wood – All Wooden Posts And Brace Members Shall Be Treated And Quality of Treated Wood Shall Provide Sufficient Strength And Last For The Expected Life Of The Fence

Corner, End, And Gate Assembly Posts For SWWF Shall Be Wooden With A Min Top Diameter Of 5"

Wooden Brace Assembly And Wooden Line Posts Shall Be A Min 7' Long With A Top Diameter Of 4"

All Brace Members Shall Be Wood And The Horizontal Member Centerline Shall Be 4'-9" Below Top Of Post. Other Brace Materials Of Equal Strength Are Allowed As Approved By The Engineer

Steel Posts Should Have The Standard "T" Section And Nominal Dimensions Of 1⅜" By 1⅜" By ⅛" With Anchor Plate. The Posts Shall Be Rolled From High Carbon Steel, Weigh At Least 1.25 Pounds Per Foot Of Length, And Shall Be Painted With A Weather Resistant Paint For Steel, Enameled And Baked, Or Hot Dip Galvanized. The Post Shall Be Studded To Aid In Wire Attachment. Steel Line Posts Shall Be A Min Length Of 5' And Shall Conform To ASTM A 702

Installation:
Line Post Spacing Shall Not Exceed 16' For SWWF, Wooden Line Posts Shall Be Set Or Driven A Min Of 24" Below The Ground Line (36" Min For Corner Posts)

Steel Line Posts Shall Be Set Or Driven A Min Of 18" Below Ground Line

If Posts Are Not Driven, The Backfill Around The Post Shall Be Well Compacted

Bracing:
All Brace Members Shall Be Wood, The Horizontal Member Centerline Shall Be 4-9" Below The Top Of The Post. The Horizontal Brace Member Shall Be A Min 4" In Dia And Min 7' In Length
A Tension Wire Composed Of 2 Complete Loops Of 9-Gauge Wire Or A Single Loop Of 12.5-Gauge High Tensile Wire Shall Be Used. And End Of The Tension Wire Shall Be At The Height Of The Horiz Cross Brace Member And The Other 4" Above Ground

WES
PROFESSIONAL ENGINEERING

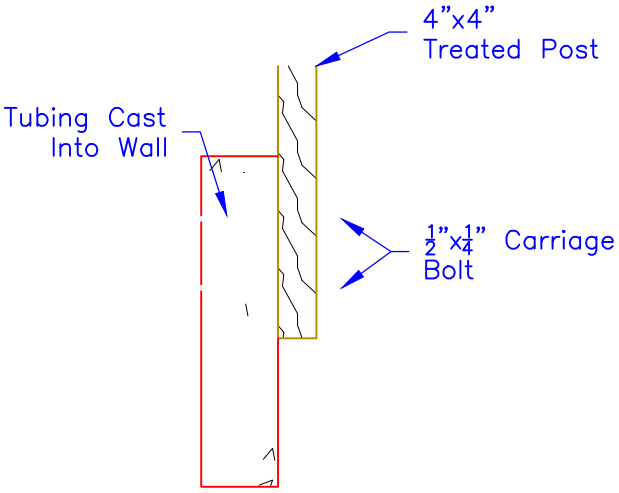
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Perimeter Safety Fence

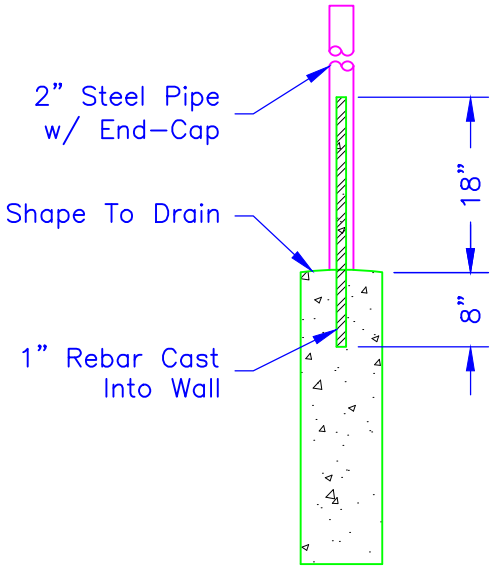
Emerald Sky Dairy, LLC

Dwg: E1

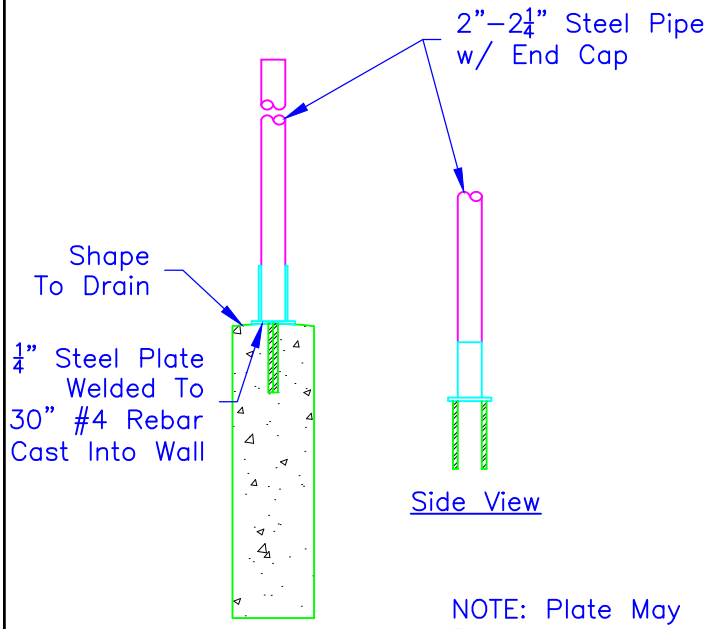
8/10/2017



Typical Section
Not Liquid Tight Option



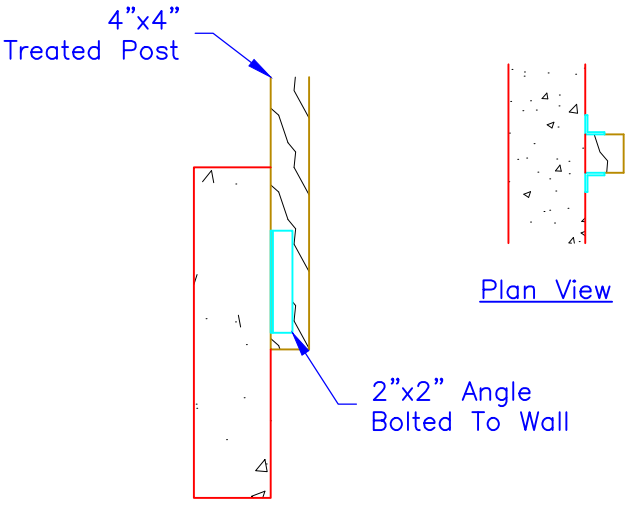
Typical Section



Side View

Typical Section

NOTE: Plate May Be Applied Using Anchor Bolts or Saddle Over Top of Wall



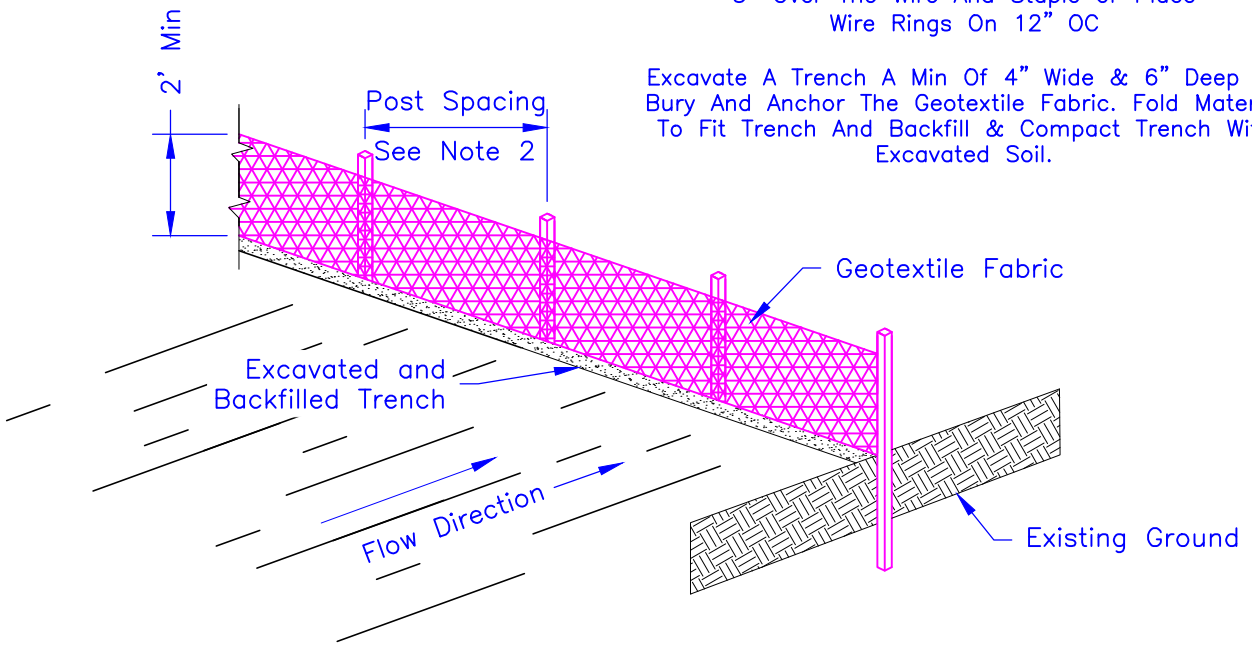
Plan View

Typical Section

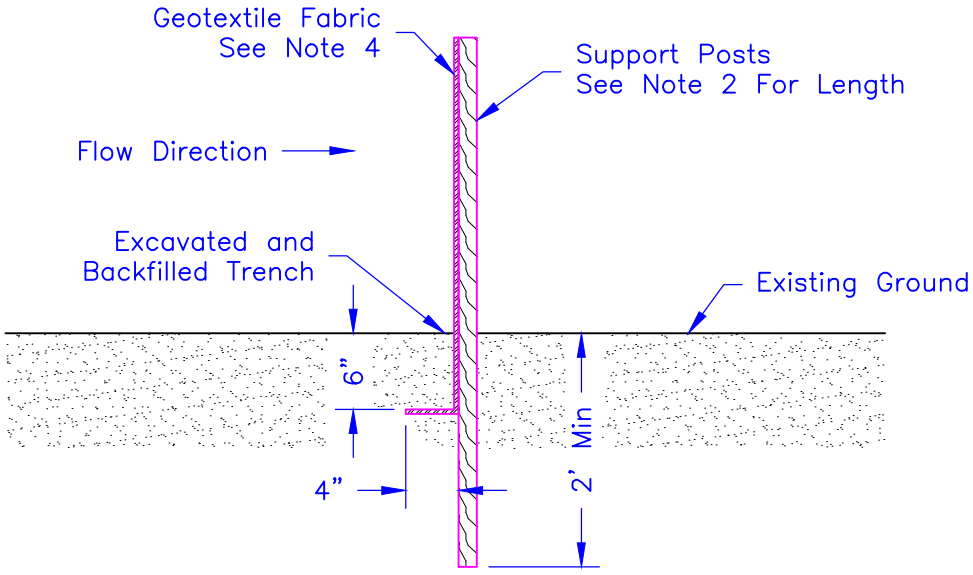
WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Fence Option Details (Typically For Use @ Push-Off) Emerald Sky Dairy, LLC	Dwg: E5 8/10/2017

Min 14 Gauge Wire Req'd Fold Fabric
3" Over The Wire And Staple or Place
Wire Rings On 12" OC

Excavate A Trench A Min Of 4" Wide & 6" Deep To Bury And Anchor The Geotextile Fabric. Fold Material To Fit Trench And Backfill & Compact Trench With Excavated Soil.



Isometric View



Typical Section

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Silt Fence Detail Emerald Sky Dairy, LLC	Dwg: E3 8/10/2017

NOTES:

1. The Geotextile Fabric Shall Be Placed in The Excavated Trench, Backfilled, and Compacted To The Existing Ground Surface.
2. Wooden Support Posts Shall Be A Minimum Dimension of 1–1/8" x 1–1/8" Air or Kiln Dried Of Hickory or Oak and 4 Feet Long. Steel Posts Shall Be Studded "Tee" or "U" Type With A Minimum Weight of 1.3 Pounds Per Lineal Foot and 5 Feet Long. Post Spacing Shall Be a Maximum of 8 Feet For Woven Fabric and 3 Feet For Non–Woven Fabric.
3. The Geotextile Fabric Shall Be Attached Directly to The Upslope Side of Wooden Posts With 0.5 Inch Staples in At Least 3 Places, or With Wooden Lath and Nails. Attachment to Steel Posts Will Be By Wire Fasteners or 50 Pound Plastic Tie Straps on The Upslope Side.
4. The Geotextile Fabric Shall Consist of Either Woven or Non–Woven Polyester, Polypropylene, Stabilized Nylon, Polyethylene, or Polyvinylidene Chloride. Non–Woven Fabric May Be Needle Punched, Heat bonded, Resin Bonded, or Combinations Thereof. All Fabric Shall Meet The Following Requirements:

TEST REQUIREMENT	METHOD	VALUE *
Minimum Grab Tensile Strength In The Machine Direction	ASTM D 4632	120 LBS.
Minimum Grab Tensile Strength In The Cross Machine Direction	ASTM D 4632	100 LBS.
Maximum Apparent Opening Size Equivalent Standard Sieve	ASTM D 4751	NO. 30
Minimum Permittivity	ASTM D 4491	0.05 SEC^{-1}
Maximum Permittivity	ASTM D 4491	0.135 SEC^{-1} OR 10 gpm/sq ft at 50 mm constant head.
Minimum Ultraviolet Stability Percentage of Strength Retained After 500 Hours of Exposure	ASTM D 4355	70%

* All Numerical Values Represent Minimum/Maximum Average Roll Values. (For Example, The Average of Minimum Test Results on Any Roll IN A Lot Should Meet or Exceed The Minimum Specified Values.)

BILL OF MATERIALS

ITEM	QUANTITY
SUPPORT POSTS	_____
GEOTEXTILE	____FT.
FASTENERS	AS REQUIRED

WES
PROFESSIONAL ENGINEERING

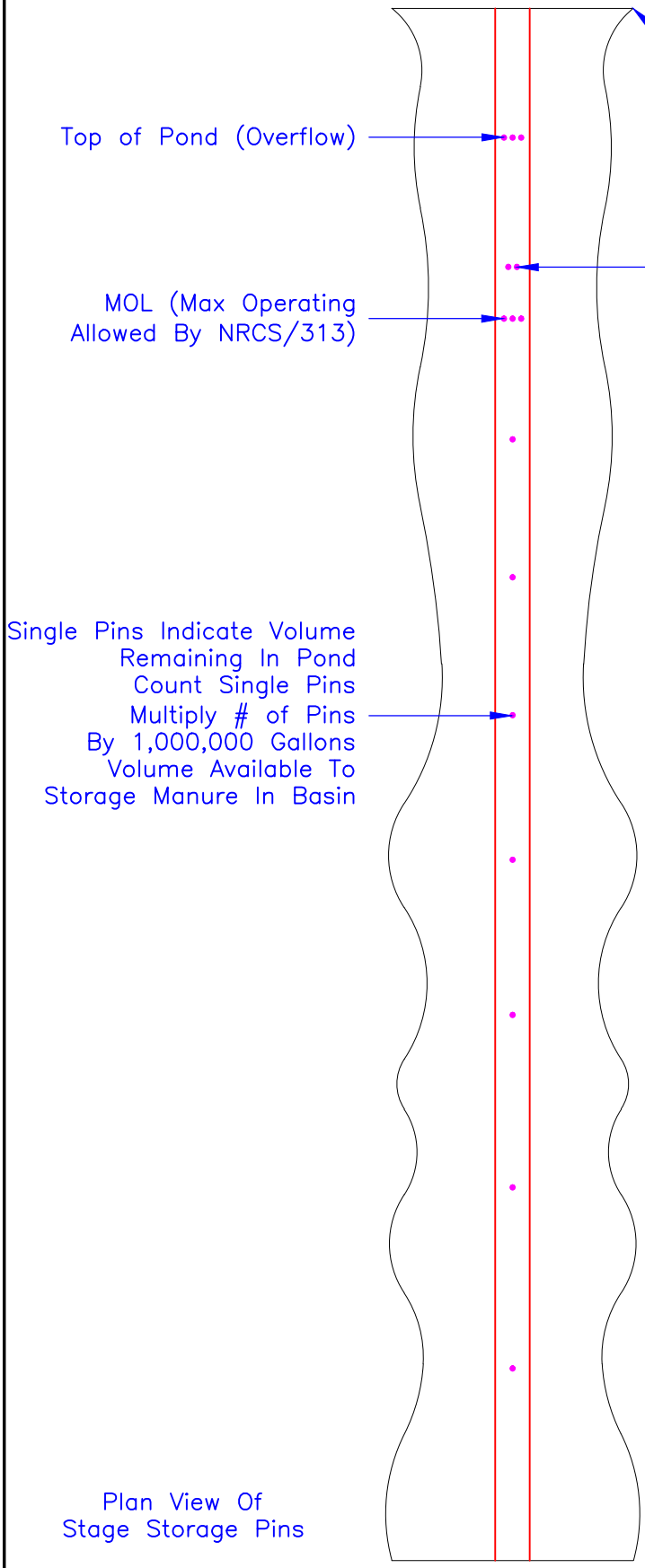
WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

Silt Fence Details

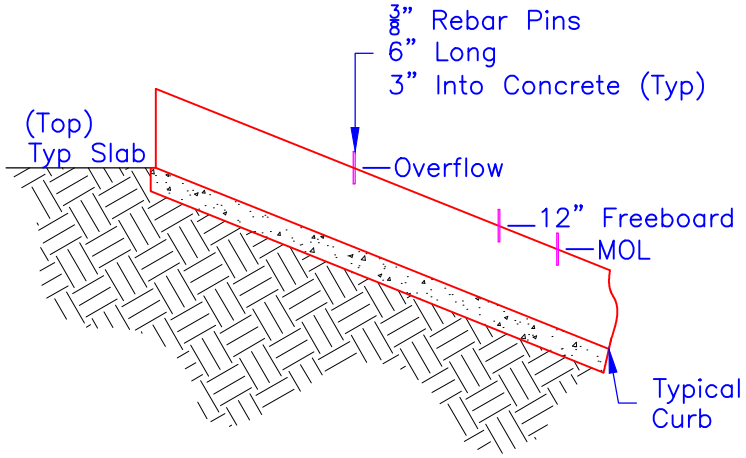
Emerald Sky Dairy, LLC

Dwg: E4

8/10/2017



Plan View Of Stage Storage Pins



Typical Curb

Note:
Engineer Shall Install Stage Storage Pins Upon Completion of Construction Based on As-Built Volume Calculations In Accordance with NR243 Requirements

WES PROFESSIONAL ENGINEERING	WILLIAMS ENGINEERING SERVICES, LLC E14910 BEARS GRASS RD AUGUSTA WI WES@CHIPVALLEY.COM 715-829-3231	Stage Storage Pins (Stage 1 Concrete WSF) Example Only Emerald Sky Dairy, LLC	Dwg: A7 8/1/2017

DANGER

DROWNING HAZARD!

SURFACE MAY
BREAK THROUGH

KEEP OFF SURFACE

DANGER

LIQUID
MANURE
STORAGE

PELIGRO

PELIGRO DE AHOGARSE!

SUPERFICIE SE
PUEDE QUEBRAR

MANTENGASE FUERA

PELIGRO

ALMACENAJE
DE
ESTIÉRCOL
LÍQUIDO

THESE ARE ONLY EXAMPLES OF THE TYPES OF SIGNS THAT MUST BE POSTED AROUND THE FACILITY. OTHER COMMERCIALLY AVAILABLE SIGNS MAY BE USED.

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715-829-3231

Typical Safety Sign Examples

Emerald Sky Dairy, LLC

Dwg: F12

8/10/2017

SEEDING DATES

TIME PERIOD	DATES			TYPE OF SEEDING
Spring	April 15	through	June 1	Permanent
Summer	June 2	through	See Page 2	See Page 2
Late Summer	August 1	through	August 21	Permanent
Fall	August 22	through	See Page 2	See Page 2
Late Fall	November 1	through	Freeze up	Dormant
Winter	No Snow Cover	through	April 14	Frost Seed

MATERIALS

Apply 2 Tons of 80–89 Lime or At A Rate As Determined By Soil Tests.
Apply 150 pounds per acre of 20–10–10 fertilizer.
Mulch with 1–1/2 tons per acre of straw or hay reasonably free from grain and weed seed. If other mulch materials are used, the rate of application shall meet the manufacturer's recommendations.

A permanent seeding shall be completed during the next acceptable time period following a temporary seeding.

MINIMUM PURE LIVE SEED (PLS)[1] RATE PER ACRE AND TOTAL POUNDS OF SEED NEEDED

SEEDING MIX	LOCATION –All Areas Per 1 UNIT ACRE	
SPECIES	RATE (Per Acre)	POUNDS Required
Smooth Bromegrass	10#	10#
Tall Fescue	2#	2#
Kentucky Bluegrass	1#	1#
Timothy	2#	2#
Perennial Ryegrass	5#	5#

SEEDING MIX_____	LOCATION _____ ACRES _____	
SPECIES	RATE (Per Acre)	POUNDS Required

1. PLS = (% Germination X % Purity)

SEEDBED PREPARATION

Prepare a fine, firm seedbed to a minimum depth of 3 inches. During the recommended seeding periods, seedbed preparation shall immediately follow construction activities.

SEEDING

Seed grasses and legumes no more than 1/4" deep. Seed may be broadcast or drilled. Seeding shall be done prior to mulching, except for dormant seedings. Inoculate legumes with the specific inoculum for the species in accordance with the manufacturer's recommendations. When using a hydroseeder, five times the recommended rate of inoculant shall be added to the hydroseeder. Inoculant shall not be mixed with liquid fertilizer.

MULCHING

Spread mulch uniformly. Straw and hay shall be applied at 1–1/2 to 2 tons (60–90 bales) per acre (6–7 strands thick). Straw mulch shall be anchored into the soil approx. 2–3" using a serrated disk. Mulch may also be anchored using liquid tackifiers or netting installed per manufacturer's recommendations. Bedding pack animal manure may also be used as mulch.

Dormant Seeding – Mulching shall be done prior to seeding and immediately after seedbed preparation.

Note:
Seed tags and fertilizer information shall be provided to Engineer

WES
PROFESSIONAL ENGINEERING

WILLIAMS ENGINEERING SERVICES, LLC
E14910 BEARS GRASS RD
AUGUSTA WI
WES@CHIPVALLEY.COM
715–829–3231

Seeding – Central region
(Page 1 of 2)

Emerald Sky Dairy, LLC

Dwg: A8

8/10/2017

Design Report

EMERALD SKY DAIRY, LLC
TOWN OF EMERALD
ST. CROIX COUNTY, WISCONSIN

Prepared by:

Williams Engineering Services, LLC
E14910 Bears Grass Road
Augusta, WI 54722
715-829-3231

August of 2017

Table of Contents

Introduction

Ronnie Williams, P.E. of Williams Engineering Services, LLC (WES) has developed this Design Summary for the proposed emergency repair to the Emerald Sky Dairy, LLC facility located in St. Croix County, Wisconsin. This emergency repair plan is intended to protect the recently remediated wetland after the manure spill that occurred in December, 2016, and to replace a waste storage facility (WSF) that was permanently damaged and only temporarily repaired. This document discusses design improvements to the waste transfer and storage system and no significant expansion is being proposed at this time. The former expansion proposal that was received by St. Croix County on October 24, 2016 has been suspended. The purpose of this document is to provide information on individual aspects and components of the project.

The Emerald Sky Dairy, LLC site has a current WPDES permit (WI-0059315-04-0) and is located south of County Highway G and bordered by 250th to the east in the Town of Emerald, St. Croix County, Wisconsin. The dairy is more specifically located in NE ¼ of NE ¼ of T30N, R16W of Section 22. The sites physical address is 2487 County Road G Emerald, WI 54013. Currently, the Emerald Sky Dairy, LLC facility consists of three freestall barns bedded with recycled manure solids, a parlor, feed pad with inadequate first flush only leachate collection, one heavily damaged and temporarily repaired 60 mil high density polyethylene (HDPE) WSF with partially removed cover, Virginia style open front heifer shed with failed and poorly performing runoff collection, calf hutch area without runoff collection and one stormwater runoff pond. The dairy also consists of remaining components of a mostly removed digester system, abandoned ECO Fuel methane collection system and a sand recovery system that are no longer in use. Only the tanks from the sand recovery system and parts of the digester system are being used at this time and much of the original systems are abandoned or have been removed.

The current site is permitted for 3,400 dairy cows per St. Croix County permit. The current site has 1,500 milking cows, 200 dry cows, 250 heifers and 350 calves. 180 milk cows are located in the most northern barn/parlor. The connecting barn contains 1,095 milking cows. The most southern (TMF) barn contains 225 milk and 200 dry maternity cows. There are 250 heifers located in the heifer shed and 350 calves located directly to the south of the heifer shed in calf hutches on dirt. The existing barns will continue to be bedded with recycled manure solids. Currently, manure in the northern barn is scraped into one of three concrete troughs below the barn floor that are connected to pipes that transfer the waste via gravity to a collection tank. This collection tank and the existing HDPE pond are connected by a pipe that allows the waste to be transferred via gravity to the HDPE pond as a backup option. Currently, the manure is pumped from the collection tank to a different collection tank located at the solid separator building. The solids are taken out of the manure stream and temporarily stored under a roof and used for bedding and the remaining liquid waste is transferred by gravity/pump to the existing WSF, depending on the liquid level of the WSF.

The manure from the TMF barn is scraped into one concrete trough that drains to the collection tank of the former sand recovery system that is located in the small building connected to the TMF barn. The manure is pumped from this collection tank to the collection tank at the solid separator building and mixed with manure from the main barns. The liquids are eventually pumped to the existing WSF after the solids are taken out by a solid separator. The piping from the TMF building to the existing solids separation area will be removed and a replacement transfer system will be rerouted to the proposed WSF. It was this original plumbing that was the cause of the December 2016 manure spill. The leachate and runoff from the existing feed pad currently flows to a manhole connected to a transfer system lift station that pumps the leachate and runoff to the collection tank at the solid separation facility and is then pumped to the existing WSF. Currently, stormwater runoff from the site flows to an existing stormwater runoff pond located in the most southern part of the facility via swales and constructed embankments. The stormwater pond currently receives contaminated runoff from the feed pad and calf hutch areas which is in conflict with NR243 goals. Existing DNR permits for the Bio digester and ECO Fuels project shall be maintained, although they are not intended to be used at this time.

Williams Engineering Services, LLC has designed the improvements to Emerald Sky Dairy, LLC. Two waste storage facilities are proposed to be constructed. One of the two WSF's will be a 3.3 million gallon liquid tight reinforced concrete pond with waterstop with an additional 12 inches of clay subliner soil material. The second WSF will be a 60 mil HDPE pond with 36 inches of clay subliner soil material. The existing HDPE pond will be abandoned in accordance with WI NRCS 360 – *Waste Facility Closure*. The northern barns will use the existing waste transfer system to transfer waste to the collection tank at the solid separation building. After solid separation, liquid waste will be pumped through a transfer pipe to the proposed concrete WSF. Additionally, a secondary emergency overflow pipe system will be constructed at the existing solid separation building to transfer liquid waste, if necessary, to a proposed feed pad leachate collection tank. The leachate and runoff collection tank will gravity flow to the concrete lined WSF. The concrete lined WSF is intended to contain residual fine organic manure solids that have not been otherwise separated out of the manure stream by the solid separation system. There will be a concrete manure solids and contaminated bedding stacking pad with waterstop north of the concrete lined WSF that will drain by gravity to the proposed concrete WSF. The two proposed ponds will be connected together by an overflow pipe and concrete channel crossover to allow for the liquid fraction of the manure to flow from the concrete pond to the HDPE lined pond. A perimeter drain tile, observation manholes, and a vent tile network will be installed.

The existing calf hutch lot located southeast of the TMF will be abandoned. The calf hutch area will be moved to a proposed liquid tight concrete lined area north of the TMF barn. A second feed pad will be constructed east of the calf hutch lot area and west of the HDPE lined WSF. The proposed calf hutch and feed pad area runoff and leachate shall flow by gravity to the TMF collection tank. Runoff and leachate will be collected in the existing collection tank north of the TMF barn and

transferred via pump to the proposed HDPE lined WSF via a new 12 inch polyethylene (PE) ASTM F714 transfer pipe.

The existing heifer barn located southeast of the TMF barn with have a wedge pit constructed on the west site that will collect runoff and allow liquid waste to be pumped to the HDPE lined WSF.

The items listed below are some of the major proposed components of the project detailed in this report:

- Concrete Lined Waste Storage Facility (WSF #1)
- HDPE Lined Waste Storage Facilities (WSF #2)
- Waste Transfer System and Pipes
    - TMF Collection Tank to WSF #1
    - Heifer Lot Collection Tank to WSF #1
    - Feed Pad Collection Tank to WSF #1
    - Solid Separator Collection Tank to WSF #1
- Proposed and Existing Feed Storage Complexes With Leachate & Runoff Collection
- Proposed Calf Hutch Area Lot with Runoff Collection
- Proposed Heifer Lot Runoff Collection
- Sand & Solids Stacking Area
- Erosion & Sediment Control Plan
- Access Roads and Heavy Use Areas
- Load Out Spill Contaminant Area

Soil Investigation

A soil investigation was conducted to determine the subsurface soil and groundwater conditions at the site. A total of 69 test pit excavations were dug throughout the site using a track mounted hoe excavator within the footprint of the proposed dairy facility components. The soil investigation work was completed based on the design requirements of each component. Excavation of test pits for the proposed dairy facility components was carried out in January, February and June of 2016 as part of the suspended 2016/2017 expansion proposal, and July of 2017 by Ronnie Williams, PE, and staff of Williams Engineering Services, LLC. All soil samples were collected during the test pit excavations. The samples were sent to the WES Office and were evaluated for moisture content, grain size and Atterberg limits. All the samples were transported, stored and tested according to ASTM Standards. A wetland delineation of the site was completed by WDNR Assured Wetland Delineator, Timothy D. King.

According to the United States Department of Agriculture Natural Resource Conservation Service (USDA-NRCS) web soil survey website, the main soil series at the proposed location is Santiago silt loam (SaB 2-6 percent slopes) comprising approximately 85 percent of the approximately 22 acre site. The site also consists of approximately 10 percent of Magnor silt loam (MaB, 0-4 percent slopes), approximately 5 percent of Freeon silt loam (FnB, 2-6 percent slopes).

The subsurface soil was regularly sandy clay material containing stones with an exception of a few sand pockets. This material was collected and tested according to ASTM Standards to determine the suitability of the earthen materials that will be later used for construction of various structures and clay subliners. After oven drying and separating the material finer than the #40 sieve, the test results concluded that the borrow material located to the west of the proposed facility was acceptable for use as WSF sub liner material. Bedrock was not observed in any of the test pits, with the deepest test pit being 24.5 feet below existing ground surface. After 24 hours, perched groundwater from sand pockets was observed in 1 of the 69 test pits, located near to a delineated wetland area, at a depth of 7.5 feet below existing ground surface. Drain tile has been included in the design due to this observation. There were no karst or sinkhole features located during field observation, or upon review of available geological maps and GIS maps produced by WES utilizing current Wisconsin Department of Natural Resources (WDNR) and St. Croix County ArcGIS layers. The subsurface soil material properties, volumes, and moisture content were considered while designing the proposed additions layout.

The soil investigation report including maps, test pit logs and laboratory testing results are detailed in the Soil Investigation Report prepared by Williams Engineering Services, LLC.

Concrete Lined Waste Storage Facility

A concrete lined with waterstop waste storage facility (WSF #1) with a 12 inch soil composite subliner is located southeast of the existing HDPE lined WSF.

WSF #1 is 20 feet deep with one pump-out sump which is two feet deep. The top footprint of WSF #1 is 220 x 180 feet. The outside berm will have a slope of 3:1 to the existing ground surface and an inside slope of 2.5:1.

WSF #1 is intended to contain fine organic manure solids that have not been otherwise separated out of the manure stream by the existing solids separation system. WSF #1 has a 20 feet wide access ramp that is sloped at a 6:1 slope in order to allow access into the facility to remove accumulated grit and manure solids for field application. The total volume (empty to full) of WSF #1 is approximately 3.3 million gallons with a total useable volume of approximately 2.9 million gallons.

The concrete waste storage facility is designed in accordance with the WI NRCS 313 – *Waste Storage Facility (January, 2014)* following Table 5, Concrete with Waterstop guidelines. Although not required by the NRCS standard, the concrete WSF will have an additional 12 inches of soil subliner layer directly under the concrete liner in accordance with the Concrete-Soil Composite section of Table 5. The facility owner has chosen to include the 12 inch clay subliner as a secondary measure to further protect groundwater above and beyond NRCS, WDNR, or County requirements.

A safety fence constructed in accordance with WI NRCS 313 will be installed around the perimeter of WSF #1, WSF #2, and stacking pad area in order to prevent animals and unapproved people from entering the WSF's. Gates will be located at all points of entry into the facility. All confined spaces and WSF's shall have safety signage warning of danger.

HDPE Lined & Covered Waste Storage Facilities

A high density polyethylene (HDPE) 60 Mil lined waste storage facility (WSF #2) with a 36 inch soil composite subliner is to be located south of the proposed WSF #1.

WSF #2 is 20 feet deep and the top footprint is 550 x 450 feet. The outside berm will have a slope of 3:1 to the existing ground surface and an inside slope of 2.5:1. The top elevation of WSF #2 berm will be 6-8 feet above the existing ground surface and the bottom of the pond will be 12-14 feet below the existing ground surface.

WSF #2 is intended to contain liquid manure, runoff water from feed and solids stacking areas, as well as milk house wash water. The total volume (empty to full) of WSF #2 is approximately 29.8 million gallons with a total useable volume of approximately 27.2 million gallons.

The HDPE WSF #2 is designed in accordance with the WI NRCS 313 – *Waste Storage Facility (January, 2014)* following the Table 3, Geomembrane Liner Criteria for Impoundments guidelines. The standard requires a 2 foot soil liner directly below the HDPE liner with greater than or equal to 40% fines and a plasticity index greater than or equal to 7. The HDPE lined WSF for Emerald Sky Dairy, LLC will comply with this standard and will have an additional 12" of soil liner. The facility owner has chosen to include the 12 inch clay subliner as a secondary measure to further protect groundwater above and beyond NRCS, WDNR, or County requirements.

A safety fence constructed in accordance with WI NRCS 313 will be installed around the perimeter of WSF #1, WSF #2, stacking pad area, feed pad collection tank, and heifer lot collection tank in order to prevent animals and unapproved people from entering these areas. Gates will be located at all points of entry into the facility. All confined spaces and WSF's shall have safety signage warning of danger.

The waste storage facilities are designed in accordance with the WI NRCS 313 – *Waste Storage Facility.*

Waste Transfer System & Pipes

An 8 inch PE ASTM F714 waste transfer pipe will be installed in the collection tank at the existing solid separation building to pump liquid waste to the WSF #1. In the event of a blockage or pump malfunction, a 12 inch overflow pipe will run from the collection tank to the proposed liquid tight feed pad collection tank, top elevation 1203.0 feet. From the feed pad collection tank, a 24 inch pipe will transfer runoff, leachate and liquid waste by gravity to the WSF #1. The 12 and 24 inch transfer pipes are constructed from dual wall PE material according to ASTM F714 . The 24 inch pipe is sloped at 0.5% starting at the feed pad collection tank, elevation 1199.0 feet, running south to the WSF #1, top elevation 1200.0 feet.

A 12 inch PE ASTM F714 waste transfer pipe will be installed at the collection tank of the former sand recovery system at the TMF barn. The 12 inch pipe will pump liquid waste collected from the proposed feed pad and calf hutch lot areas, and the TMF barn to WSF #1.

An 8 inch PE ASTM F714 pipe will be installed at the heifer lot collection tank located southeast of the TMF barn. This pipe will pump liquid waste to WSF #1.

The flush flume transfer pipeline system is designed in accordance with WI NRCS 634 – *Waste Transfer.*

Feed Storage Complex With Leachate & Runoff Collection

A proposed 350 feet by approximately 275 feet (irregular shape) concrete with waterstop feed storage pad is proposed on the northeast side of the TMF barn to store silage and other feed materials. The total feed pad area is approximately 88,993 square feet. The feed pad and work areas will be constructed of an 8-inch thick concrete slab with waterstop over a compacted gravel base and sloped at approximately 1.0% toward a runoff and leachate collection trough to the west in the calf hutch lot area. The swale along the south wall of the calf hutch lot area will transport leachate and precipitation runoff via gravity to the collection tank north of the TMF barn and then pumped to the proposed WSF #1. The gravity flow channel in the calf hutch lot area and the 12 inch PE transfer pipe has the capacity to collect and transfer the leachate and precipitation runoff from a 25-year/24-hour runoff storm event from all paved areas. The calf hutch area lot and feed pad will have perimeter walls to contain runoff during rain events.

The volume accumulated from the feed storage, calf hutch lot area, and heifer lot area has been taken into account when designing the proposed waste storage facility #1 and #2.

The existing feed storage pad currently only collects the base leachate and a small amount of the initial runoff event. The runoff collection system will be modified to include a collection tank with a 24-inch diameter dual wall HDPE corrugated pipe which will transfer the feed pad runoff to a proposed concrete WSF #1 via gravity flow. The feed pad leachate collection tank and 24 inch pipe has the capacity to collect and transfer the leachate and precipitation from a 25-year/24-hour runoff storm event. The volume accumulated from the feed storage area has been taken into account when designing the proposed waste storage facility #1 and #2.

The feed storage pad and leachate collection systems were designed in accordance with the WI NRCS 629 - *Waste Treatment*. The pumping station has been designed in accordance with WI NRCS 430 - *Irrigation Pipeline*, WI NRCS 533 - *Pumping Plant* and WI NRCS 634 – *Waste Transfer*.

Separation System & Stacking Area

Emerald Sky Dairy, LLC will utilize the existing mechanical solids separation system to remove manure solids and bedding from the northern barns. The facility is located directly to the south of the existing feed pad area. The existing waste transfer pipes will transfer the waste to the separation facility. The liquids will be transferred to the waste storage facilities and the removed manure solids will be stacked on a concrete stacking slab under a roof until the solids are used for bedding or land applied in accordance with the facility's approved nutrient management plan. The remaining liquid waste will be pumped through an 8 inch PE pipe to the proposed concrete lined WSF #1.

A 14,382 square foot concrete stacking pad complex with 2-4 foot retaining walls is located directly north of the concrete lined WSF #1. The stacking area will consist of a temporary manure solids and contaminated calf bedding storage area.

Leachate water and runoff from the stacking area will be collected and transferred to the proposed concrete lined WSF #1 via gravity flow.

The wastewater collection system was designed in accordance with WI NRCS 634 – *Waste Transfer*, WI NRCS 632 – *Solid/Liquid Waste Separation Facility* and WI NRCS 533 – *Pumping plant*.

Erosion & Sediment Control Plan

The Emerald Sky Dairy site is roughly 86 acres and approximately 24 acres will be disturbed during the construction of the dairy facility. WES is working with the DNR on the stormwater permitting. Some off-site areas (included in the disturbed area calculation) will also be disturbed as temporary stockpiles of topsoil and clay materials will be excavated/placed just west of the facility.

During all phases of construction, erosion and sediment controls will be implemented to avoid discharge of sediment-laden runoff from the facility. Except for the borrow area, runoff from all areas of the disturbed site will flow to the existing stormwater pond. WDNR Best Management Practices (BMPs) will be utilized in any applicable situation in all disturbed areas. Erosion control practices that may be utilized include silt fencing, vehicle tracking pads, erosion mats, culvert sediment traps, rock check dams, straw bale ditch checks, and temporary and permanent seeding. All erosion control devices will be maintained until all disturbed areas of the facility are completely stabilized and vegetated areas have sufficient growth to be able to resist erosion. Vegetative coverage of at least 70 percent is required to be able to submit a Notice of Termination (NOT) Form to the WNDR. Upon approval, all temporary erosion and sediment control devices will be removed.

After erosion control site preparation is complete, topsoil will be stripped from the site and stacked in designated areas. The stockpiles will be seeded and encompassed by a silt fence. The stockpiles are to be located in areas with sufficient distance from roadways, floodplains and waterway drainage routes. In order to prevent dust during dry periods of construction, disturbed areas will be seeded and mulched as soon as possible. Watering work areas and driveways will be performed on an as-needed basis and at the direction of the facility operator.

Weekly visual inspections by WES personnel of erosion and sediment control devices will be conducted to evaluate effectiveness. After rainfall events greater than 0.25 inches, additional inspection will be done by onsite personnel to evaluate the erosion control effectiveness or determine if any repairs are required.

The secondary containment berm located to the south of the existing calf hutch area is designed to contain an accidental spill or breach of the WSF structures. Also, the secondary containment berm will act as temporary emergency sedimentation pond during construction and a permanent stormwater detention basin for runoff from the site. The secondary containment berm has one water level control outlet pipe structure which directs stormwater discharge to upland reaches of the wetland area located to the west of the site. Clean

stormwater discharges from the borrow area site will be directed to upland reaches of the wetland area below the site

Access Roads & Heavy Use Areas

Minimal access roads and heavy use areas will be constructed around the proposed facility to allow for access to all housing structures, waste storage facilities, feed storage areas, stacking areas and heavy use areas. Existing on-site driveways will be used/maintained. Some additional concrete access roads and heavy use protection areas may be constructed of 8 inch thick reinforced concrete. All access roads will be graded to drain storm water runoff and to prevent ponding.

ATTACHMENT 1
WASTE STORAGE FACILITY DESIGN

Client:	Emerald Sky Dairy, WI
Address:	St. Croix County
Date:	6/16/2017
Project:	Conceptual Design
Days Of Storage:	378

Location:	WI, St croix
25 yr. rain	4.7

NOTE: Feed Pad & Cannery Pad Info Should Be Entered Here (Not In Pond Tabs) - Summary Sheet Used Pond Data And This Data

Water Runoff Areas Collected

Total Farmstead Runoff Area Collected (Includes Feed & Cannery Pads)=	321316	SF
Runoff Area B (Proposed Heifer Lot) =	6600	SF
Runoff Area C (Proposed Stacking Pad) =	8790	SF
Total Runoff Area Collected (After Subtracting Out Pads)=	15390	SF
Existing Water Runoff Areas Collected (Ave Precip.)=	321291	Gallons
Existing Water Runoff Areas Collected (25 Yr Event)=	45088	Gallons

Existing Feed Pad

Collects First Flush=	Yes	Yes/No
Collects All Runoff=	Yes	Yes/No
Existing Feed Pad Area/Proposed Calf Hutch Area/Proposed Feedpad (Emerald Site)=	321,316	SF
Pounds Dry Matter Fed Per Day Per Milk Cow =	0	Lb
Feed % Moisture=	60%	
Tons Of Stored Feed Required (Annually)=	0	(Based On Percentage By Weight Of Milk Cow)
Tons Of Feed Stored (Annually)=		Tons
Cubic Feet Of Leachate Per Ton Feed=	0	CF
Gallons of Leachate=	0	Gallons
First Flush Depth Of Runoff=	0	Inches
Average Annual Runoff Collected By First Flush=	0.0	Inches
Average Annual Volume of First Flush Collected=	0	Gallons
Volume of First Flush Collected During Days Of Storage=	0	Gallons
Existing Feed Pad Runoff Collected (Ave Precip.)=	6707978	Gallons
Existing Feed Pad Runoff Collected (25 Yr Event)=	941349	Gallons

Proposed/Future Feed Pad

Collects First Flush=	No	Yes/No
Collects All Runoff=	Yes	Yes/No
Future Feed Pad Area=	0	SF
Pounds Dry Matter Fed Per Day Per Milk Cow =	0	Lb
Feed % Moisture=	0%	
Tons Of Feed Stored (Annually)=	0	Enter Tons To Be Stored On Future Pad Area
Cubic Feet Of Leachate Per Ton Feed=	0	CF
Gallons of Leachate=	0	Gallons
First Flush Depth Of Runoff=	0	Inches
Average Annual Runoff Collected By First Flush=	0.0	Inches
Average Annual Volume of First Flush Collected=	0	Gallons
Volume of First Flush Collected During Days Of Storage=	0	Gallons
Gallons Of Proposed/Future Feed Pad Runoff Collected=		Gallons
Existing Feed Pad Runoff Collected (Ave Precip.)=	0	Gallons
Existing Feed Pad Runoff Collected (25 Yr Event)=	0	Gallons

	Number	Weight	Manure CF	Bedding CF	CF/Day	Days	Total Manure (CF)	Total Manure (Gal)	Animal Units
Milk Cows	1700	1400	2.7	0.5	5440	378	2056320	15381274	2380
Heifers	250	1100	1.1	0.5	400	378	151200	1130976	275
Heifers	0	600	0.8	0.1	0	378	0	0	0
Calves	350	200	0.2	0.1	105	378	39690	296881	70
	2300		Bedding (Gallons)=	368550	5945		**2,247,210**	**16,809,131**	**2725**

Milkhouse Wash Water Per Milking Cow=	8 Gallons

Annual Precip=	33. Inches
25 Yr-24 Hr Event=	4.7 Inches
Annual Pond Evap=	21. Inches
Annual Precip-Evap=	12. Inches
Storage Duration =	378 Days
Paved Areas Average Annual Runoff Percentage (Based On 98 Curve Number)=	98%
Farmstead Areas Average Annual Runoff Percentage (Based On 84 Curve Number)=	98%
Trap Efficiency Of Sand Lane=	0%

Total Clean Water Runoff Area Collected=	366378	Gallons
Total Milkhouse Wash Water=	5140800	Gallons
Feed Pad Leachate=	0	Gallons
Cannery Pad Leachate=	0	Gallons
Feed Pad First Flush=	0	Gallons
Existing Feed Pad Runoff Collected=	7649327	Gallons
Proposed/Future Feed Pad Runoff Collected=	0	Gallons
Existing Cannery Pad Runoff Collected=	0	Gallons
Proposed Cannery Pad Runoff Collected=	0	Gallons
Total Wastewater=	**13,156,505**	**Gallons**
(Milkhouse, Leachate, Pad Runoff & First Flush)		
Total Liqud Waste Collected (Manure & Wastewater):	**29,965,636**	**Gallons**

ver. 12/31/13 | Landowner: Emerald Sky Dairy, W | Pond Option 2 for: 270 Days | Location: WI, St croix

Cows: 1700 | 25 yr. storm: 4.7

Additional Pond Volume:		gal	
Manure Volume:	17,104,159	gal	
Wastewater (Cannery Leachate):	0	gal	
Precipitation Collected From Area Listed Below:	581,827	gal	Ave. 270 Day Runoff
Evaporation From Pond:	-370,254	gal	

Replacements for values if overwritten:

10,495 →	Total Contributing Area (surface area) of Stage 1:	10,495 (top of pit to c/l of wall has been used)
27,742 →	Total Contributing Area (surface area) of Stage 2:	27,742 (top of pit to c/l of wall has been used)
	Total Contributing Area (surface area) of Pit:	38,237 (top of pit has been used)
	Additional Contributing Area:	0.00 sq ft
	Additional Contributing Area (Farmstead):	0.00 sq ft
	Additional Contributing Area - (Not Including 25 YR Event):	0.00 sq ft
	Total Area for 25 yr rain amount:	38,237 sq ft
	25 yr rain volume (gal):	112,023
	Total Volume Of Wastes & Ave. Precip. To Store (below Freeboard):	17,315,733
	Pit Vol to Top	**3,278,931 (includes all sumps)**

Vol of Accumulated solids-Stage 1
(if a depth > 0 given, will include Drive-In sump, sump(s), and vol. for depth above pit floor):

	Total Vol Stage 1 (To Top Of Wall):	3,939 gal
	Volume of Drive In Sump:	0 gal
→	Stage 1 Vol of sump(s):	3,939 gal
		0 gal
	Usable Volume in Stage 1 (regular sumps not included as usable) :	**0 (gal.)**
		0 (cu. ft.)
		0 (cu. yd.)

Vol of Accumulated solids-Stage 2
(if a depth > 0 given, will include sump(s), and vol. for depth above pit floor):

	Total Vol Stage 2 (To Top Of Wall):	0 gal
→	Stage 2 Vol of sump(s): (included below)	gal
		0 gal
	Usable Volume in Stage 2 (regular sumps not included as usable) :	**0 (gal.)**
		0 (cu. ft.)
		0 (cu. yd.)

Single Stage Pit Design

Usable Pit volume AT WALL TOP: 0 (gal.)

	Elevation at Freeboard:	1199.00 start top:	324
	Total Volume at Freeboard:	**3,000,059 (gal.)**	420
	25 yr rain volume (gal):	112,023	421
	Volume at MOL (Vol. at Freeboard-25 yr rain vol.) :	**2,888,036 (gal.)**	417
	Elevation of MOL:	**1198.58**	418
	Usable Storage below FB (25 yr rain, sumps & accum. solids not included) :	**2,884,097 (gal.)**	
	Total Volume Of Wastes & Ave. Precip. To Store (Below Freeboard):	**17,315,733 (gal.)**	
	Extra Un-Used Volume Remaining:	**-14,431,636 (gal.)**	

2-Stage Structure: FALSE

Berm Width: 12.00

Ramp

Include Ramp:	TRUE
Ramp Directional:	Left
Ramp Width:	20.00
Ramp Slope:	6.00
Ramp Access (at pit bottom):	40.00
Ramp Outset:	0.00

General Depths

Top Elev:	1200.00		Freeboard Elevation:
Freeboard:	1.00		1199.00
Depth-Stage 1:	20.00	Depth-Stage 2:	20.00
Bottom Elev-Stage 1:	1180.00	Bottom Elev-Stage 2:	1180.00
Bottom Len.-Stage 1:	120	Bottom Len.-Stage 2:	120
Bottom Wid.-Stage 1: (widest)	0	Bottom Wid.-Stage 2:	80

Wall/Hump data

Wall Ht (overflow):	0.00	1180.00 Wall Top Elevation
Wall Thickness (ft):	0.00	
Wall Distance (from toe-Stage 1):	0.00	
Hump Ht:	0.00	(above least deep part of a 2-stage design)
Hump Width-Stage 1 side:	0.00	1180.00 Hump Top Elevation
Hump Slope-Stage 1 side:	0.00	
Hump Width-Stage 2 side:	0.00	
Hump Slope-Stage 2 side:	0.00	

Pit Side Slope:	2.50	(in ratio - 2 if 2:1)
Pit Top Length:	220	(208 min. length)
Pit Top Width:	180	

ver. 12/31/13 | Landowner: Emerald Sky Dairy, W | Pond Option 3 for: 365 Days | Location: WI, St croix

Cows: 1700 | 25 yr. storm: 4.7

Additional Pond Volume:	0	gal	
Manure Volume:	22,496,143	gal	
Wastewater (Cannery Leachate):	0	gal	
Precipitation Collected From Area Listed Below:	5,063,610	gal	Ave. 270 Day Runoff
Evaporation From Pond:	-3,222,297	gal	

Replacements for values if overwritten:

27,023 →	Total Contributing Area (surface area) of Stage 1:	27,023 (top of pit to c/l of wall has been used)
219,142 →	Total Contributing Area (surface area) of Stage 2:	219,142 (top of pit to c/l of wall has been used)

Total Contributing Area (surface area) of Pit:	246,165	(top of pit has been used)
Additional Contributing Area:	0.00	sq ft
Additional Contributing Area (Farmstead):	0.00	sq ft
Additional Contributing Area - (Not Including 25 YR Event):	0.00	sq ft
Total Area for 25 yr rain amount:	246,165	sq ft
25 yr rain volume (gal):	721,181	
Total Volume Of Wastes & Ave. Precip. To Store (below Freeboard):	24,337,456	
Pit Vol to Top	**29,769,141**	**(includes all sumps)**

Vol of Accumulated solids-Stage 1
(if a depth > 0 given, will include Drive-In sump, sump(s), and vol. for depth above pit floor):

Total Vol Stage 1 (To Top Of Wall):	3,939	gal
Volume of Drive In Sump:	0	gal
Stage 1 Vol of sump(s):	3,939	gal
	0	gal
Usable Volume in Stage 1 (regular sumps not included as usable) :	**0**	**(gal.)**
	0	(cu. ft.)
	0	(cu. yd.)

Vol of Accumulated solids-Stage 2
(if a depth > 0 given, will include sump(s), and vol. for depth above pit floor):

Total Vol Stage 2 (To Top Of Wall):	0	gal
Stage 2 Vol of sump(s):	(included below)	gal
	0	gal
Usable Volume in Stage 2 (regular sumps not included as usable) :	**0**	**(gal.)**
	0	(cu. ft.)
	0	(cu. yd.)

Single Stage Pit Design

Usable Pit volume AT WALL TOP:	**0**	**(gal.)**
Elevation at Freeboard:	1199.00	start top:
Total Volume at Freeboard:	**27,946,512**	**(gal.)**
25 yr rain volume (gal):	721,181	
Volume at MOL (Vol. at Freeboard-25 yr rain vol.) :	**27,225,332**	**(gal.)**
Elevation of MOL:	**1198.6**	
Usable Storage below FB (25 yr rain, sumps & accum. solids not included) :	**27,221,392**	**(gal.)**
Total Volume Of Wastes & Ave. Precip. To Store (Below Freeboard):	**24,337,456**	**(gal.)**
Extra Un-Used Volume Remaining:	**2,883,936**	**(gal.)**

lookups	
324	
420	
421	
417	
418	

2-Stage Structure: FALSE

Berm Width: 12.00

Ramp

Include Ramp:	TRUE
Ramp Directional:	Right
Ramp Width:	20.00
Ramp Slope:	10.00
Ramp Access (at pit bottom):	40.00
Ramp Outset:	0.00

General Depths

Top Elev:	1200.00		Freeboard Elevation:
Freeboard:	1.00		1199.00
Depth-Stage 1:	20.00	Depth-Stage 2:	20.00
Bottom Elev-Stage 1:	1180.00	Bottom Elev-Stage 2:	1180.00
Bottom Len.-Stage 1:	450	Bottom Len.-Stage 2:	450
Bottom Wid.-Stage 1: (widest)	0	Bottom Wid.-Stage 2:	350

Wall/Hump data

Wall Ht (overflow):	0.00	1180.00 Wall Top Elevation
Wall Thickness (ft):	0.00	
Wall Distance (from toe-Stage 1):	0.00	
Hump Ht:	0.00	(above least deep part of a 2-stage design)
Hump Width-Stage 1 side:	0.00	1180.00 Hump Top Elevation
Hump Slope-Stage 1 side:	0.00	
Hump Width-Stage 2 side:	0.00	
Hump Slope-Stage 2 side:	0.00	

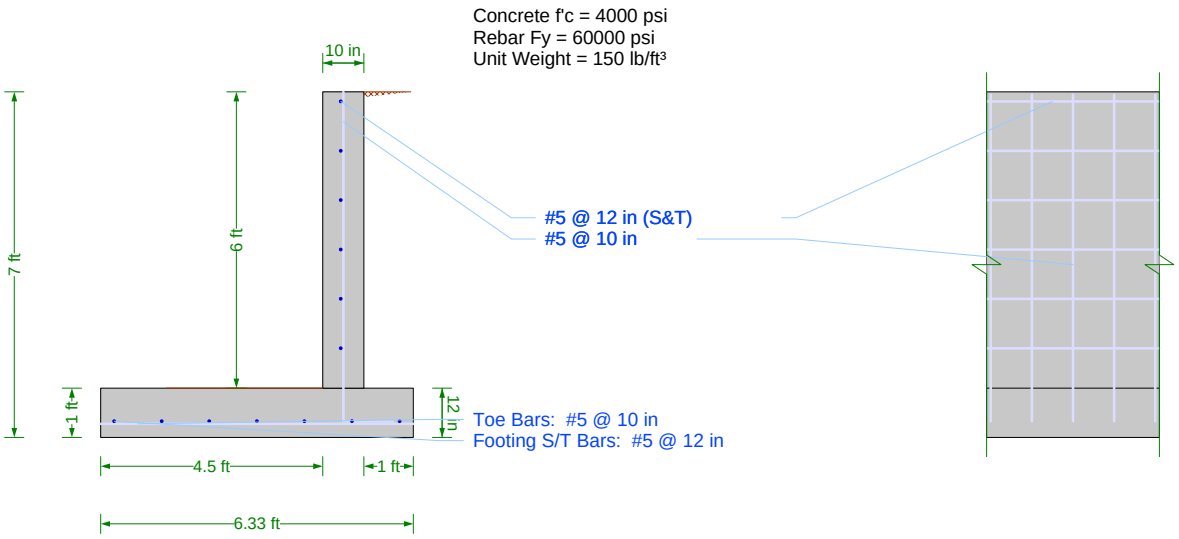
Pit Side Slope:	2.50	(in ratio - 2 if 2:1)
Pit Top Length:	550	(289 min. length)
Pit Top Width:	450	

ATTACHMENT 2
WALL DESIGN CALCULATIONS

RONNIE WILLIAMS, PE
WILLIAMS ENGINEERING SERVICES

Emerald Sky Dairy 6ft Wall

Design Detail



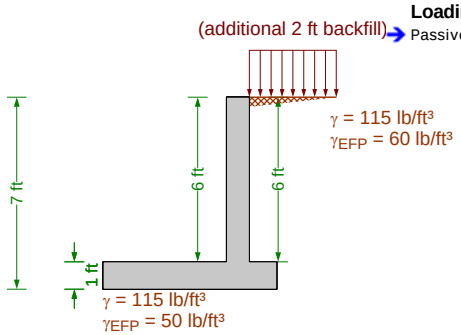
Check Summary

Ratio	Check	Provided	Required	Combination
----- Stability Checks -----				
✓ 0.799	Overturning	1.88	1.50	0.6D + 1.0H
✓ 0.268	Bearing Pressure	3000 psf	803.2 psf	1.0D + 1.0L + 1.0H
✓ 0.942	Bearing Eccentricity	11.93 in	12.67 in	1.0D + 1.0L + 1.0H
----- Toe Checks -----				
✓ 0.200	Shear	9.89 k/ft	1.98 k/ft	1.2D + 1.6L + 1.6H
✓ 0.420	Moment	14.08 ft·k/ft	5.91 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.107	Min Strain	0.0375	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0.03 in²	0 in²	1.2D + 1.6L + 1.6H
✓ 0.632	Development	19 in	12 in	1.2D + 1.6L + 1.6H
✓ 0.667	S&T Max Spacing	12 in	18 in	1.2D + 1.6L + 1.6H
✓ 0.836	S&T Min Rho	0.0022	0.0018	1.2D + 1.6L + 1.6H
----- Heel Checks -----				
✓ 0.227	Shear	6.07 k/ft	1.38 k/ft	1.2D + 1.6L + 1.6H
✓ 0.218	Moment	3.16 ft·k/ft	0.69 ft·k/ft	1.2D + 1.6L + 1.6H
----- Stem Checks -----				
✓ 0.874	Moment	7.91 ft·k/ft	6.91 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.506	Shear	5.69 k/ft	2.88 k/ft	1.2D + 1.6L + 1.6H
✓ 0.197	Max Steel	0.0203	0.0040	1.2D + 1.6L + 1.6H
✓ 0.538	Min Steel	0.03 in²/in	0.02 in²/in	1.2D + 1.6L + 1.6H
✓ 0.806	Base Development	9 in	7.25 in	1.2D + 1.6L + 1.6H
✓ 0.774	Horz Bar Rho	0.0026	0.0020	1.2D + 1.6L + 1.6H
✓ 0.667	Horz Bar Spacing	12 in	18 in	1.2D + 1.6L + 1.6H

Criteria

Building Code	IBC 2012
Concrete Load Combs	IBC 2012 (Strength)
Masonry Load Combs	ASCE 7-10 (ASD)
Stability Load Combs	ASCE 7-10 (ASD)
Restrained Against Sliding	Yes
Neglect Bearing At Heel	Yes
Use Vert. Comp. for OT	No
Use Vert. Comp. for Sliding	No
Use Vert. Comp. for Bearing	Yes
Use Surcharge for Sliding & OT	Yes
Use Surcharge for Bearing	Yes
Neglect Soil Over Toe	No
Neglect Backfill Wt. for Coulomb	No
Factor Soil Weight As Dead	Yes
Use Passive Force for OT	Yes
Assume Pressure To Top	Yes
Extend Backfill Pressure To Key Bottom	No
Use Toe Passive Pressure for Bearing	No
Required F.S. for OT	1.50
Required F.S. for Sliding	1.50
Has Different Safety Factors for Seismic	No
Allowable Bearing Pressure	3000 psf
Req'd Bearing Location	Middle third
Wall Friction Angle	25°
Friction Coefficent	0.35
Soil Reaction Modulus	172800 lb/ft³

Loads



Loading Options/Assumptions

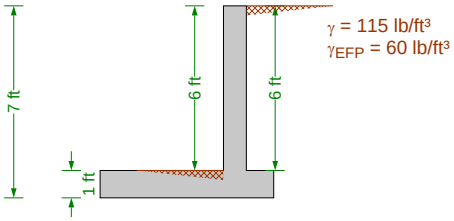
Passive pressure neglects top 0 ft of soil.

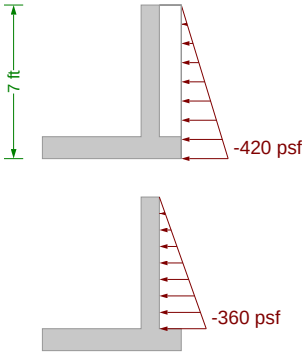
Load Combinations

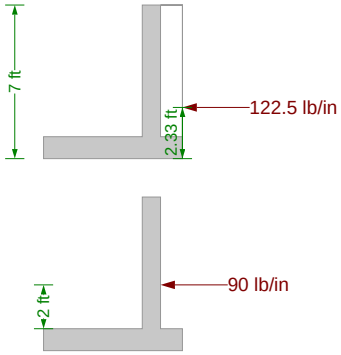
IBC 2012 (Strength)

1.2D + 1.6L + 1.6H
1.2D + 1.6L + 0.9H
1.2D + 0.5L + 1.6H
1.2D + 0.5L + 0.9H
1.2D + 1.6H
1.2D + 0.9H
0.9D + 1.6H
0.9D + 0.9H
1.4D

Backfill Pressure







Lateral Earth Pressure

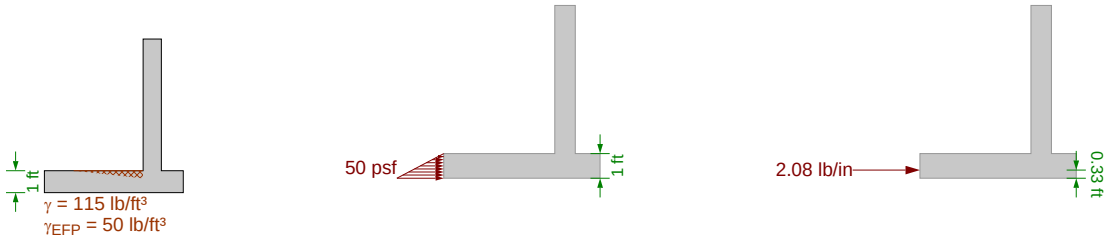
Equivalent Fluid Pressure

$\sigma_h = H\,\gamma_{fluid}$ = (7 ft)(60 lb / ft³) = 420 psf

Lateral Earth Pressure (stem only)

$\sigma_h = H\,\gamma_{fluid}$ = (6 ft)(60 lb / ft³) = 360 psf

Passive Pressure

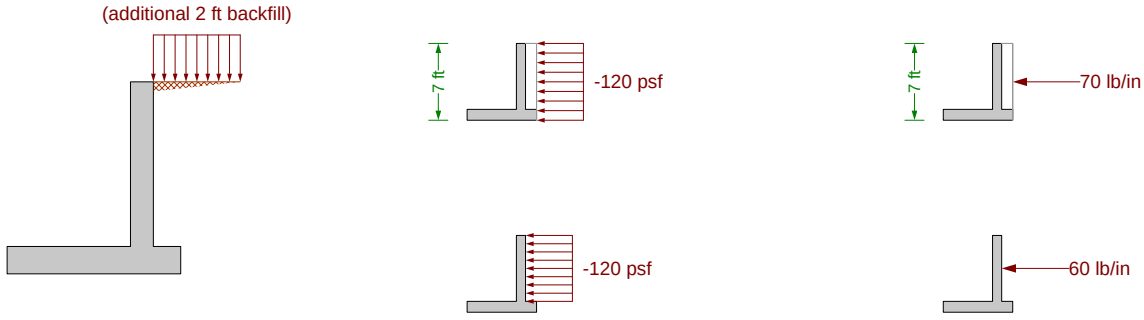


Lateral Earth Pressure

Equivalent Fluid Pressure

$\sigma_h = H\ \gamma_{fluid} = (1\ ft)(50\ lb / ft^3) = 50\ psf$

Uniform Surcharge Pressure



Lateral Surcharge Pressure

$q = \gamma\ H_{sur} = (115\ lb / ft^3)(2\ ft) = 230\ psf$

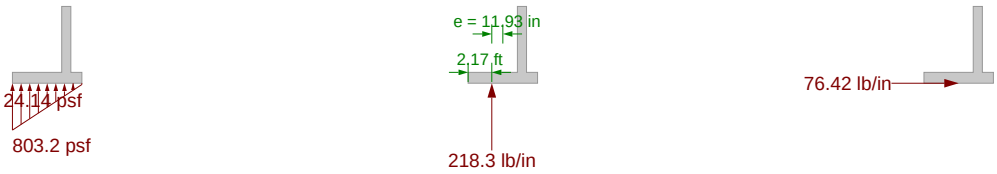
Equivalent Fluid Pressure

$K = \frac{\gamma_{fluid}}{\gamma} = \frac{(60\ lb / ft^3)}{(115\ lb / ft^3)} = 0.5217$

$\sigma_{sur} = K\ q = (0.5217)(230\ psf) = 120\ psf$

Wall/Soil Weights

Bearing Pressure



Friction

$F = \mu R = (0.350)(218.3 \text{ lb / in}) = 76.42 \text{ lb / in}$

Bearing Pressure Calculation

Contributing Forces

	Vert Force	...offset	Horz Force	...offset	OT Moment
Backfill Pressure	-0 lb/in	-	-122.5 lb/in	2.33 ft	41160 in·lb/ft
Uniform Surcharge Pressure	-19.17 lb/in	5.83 ft	-70 lb/in	3.5 ft	19180 in·lb/ft
Footing Weight	-79.17 lb/in	3.17 ft	0 lb/in	-	-36100 in·lb/ft
Stem Weight	-62.5 lb/in	4.92 ft	0 lb/in	-	-44250 in·lb/ft
Backfill Weight	-57.5 lb/in	5.83 ft	0 lb/in	-	-48300 in·lb/ft
Soil over toe Weight	-0 lb/in	-	0 lb/in	-	-0 in·lb/ft
	-218.33 lb/in				-68310 in·lb/ft

$$\frac{-68310 \text{ in·lb / ft}}{-218.33 \text{ lb / in}} = 2.17 \text{ ft}$$

Stability Checks [1.0D + 1.0L + 1.0H]

Overturning Check

Overturning Moments

	Force	Distance	Moment
Backfill pressure (horz)	122.5 lb/in	2.33 ft	41160 in·lb/ft
Surcharge (uniform) lateral pressure	70 lb/in	3.5 ft	35280 in·lb/ft
		Total:	76440 in·lb/ft

Resisting Moments

	Force	Distance	Moment
Surcharge (uniform) vertical pressure	19.17 lb/in	5.83 ft	16100 in·lb/ft
Passive pressure @ toe	2.08 lb/in	0.33 ft	100 in·lb/ft
Footing Weight	-79.17 lb/in	3.17 ft	36100 in·lb/ft
Stem Weight	-62.5 lb/in	4.92 ft	44250 in·lb/ft
Backfill Weight	-57.5 lb/in	5.83 ft	48300 in·lb/ft
Soil over toe Weight	-0 lb/in	2.25 ft	0 in·lb/ft
		Total:	144850 in·lb/ft

$$\text{F.S.} = \frac{\text{RM}}{\text{OTM}} = \frac{144850 \text{ in·lb / ft}}{76440 \text{ in·lb / ft}} = 1.895 > 1.50 \text{ (OK)}$$

Sliding Check

Check not performed; restrained against sliding.

Bearing Capacity Check

Bearing pressure < allowable (803.2 psf < 3000 psf) - OK
Bearing resultant eccentricity < allowable (11.93 in < 12.67 in) - OK

Wall Top Displacement

(based on unfactored service loads)

Deflection due to stem flexural displacement	0.017 in
Deflection due to rotation from settlement	0.051 in
Total deflection at top of wall (positive towards toe)	0.068 in

Stability Checks [0.6D + 1.0H]

Overturning Check

Overturning Moments

	Force	Distance	Moment
Backfill pressure (horz)	122.5 lb/in	2.33 ft	41160 in·lb/ft
Surcharge (uniform) lateral pressure	0 lb/in	3.5 ft	0 in·lb/ft
		Total:	41160 in·lb/ft

Resisting Moments

	Force	Distance	Moment
Surcharge (uniform) vertical pressure	0 lb/in	5.83 ft	0 in·lb/ft
Passive pressure @ toe	2.08 lb/in	0.33 ft	100 in·lb/ft
Footing Weight	-47.5 lb/in	3.17 ft	21660 in·lb/ft
Stem Weight	-37.5 lb/in	4.92 ft	26550 in·lb/ft
Backfill Weight	-34.5 lb/in	5.83 ft	28980 in·lb/ft
Soil over toe Weight	-0 lb/in	2.25 ft	0 in·lb/ft
		Total:	77290 in·lb/ft

$$F.S. = \frac{RM}{OTM} = \frac{77290 \text{ in·lb / ft}}{41160 \text{ in·lb / ft}} = 1.878 > 1.50 \text{ (OK)}$$

Sliding Check

Check not performed; restrained against sliding.

Bearing Capacity Check

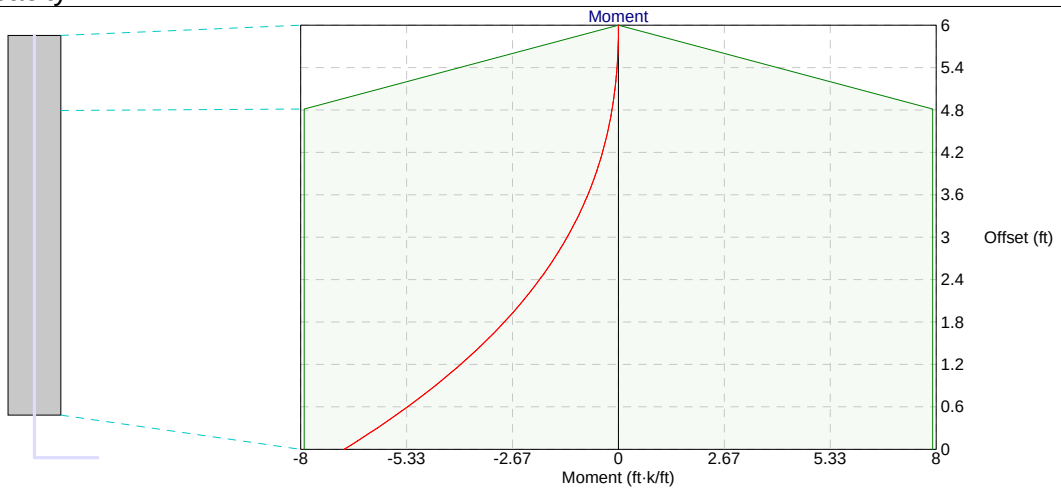
Bearing pressure < allowable (439.6 psf < 3000 psf) - OK
Bearing resultant eccentricity < allowable (11.93 in < 12.67 in) - OK

Wall Top Displacement

(based on unfactored service loads)

Deflection due to stem flexural displacement	0.017 in
Deflection due to rotation from settlement	0.051 in
Total deflection at top of wall (positive towards toe)	0.068 in

Stem Flexural Capacity



Capacity (ACI 318-11 10.2) @ 0 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 0 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 4.81 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 4.81 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 6 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

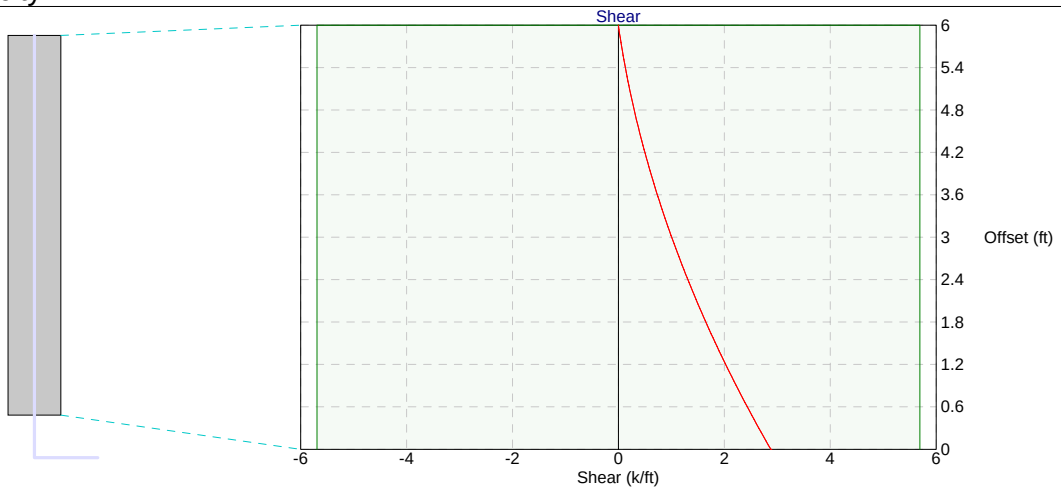
$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 6 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Stem Shear Capacity



Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 0 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi\, V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 0 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi\, V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 6 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi\, V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 6 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi\, V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Stem Development/Lap Length Calculations

Main vertical stem bars (bottom end) - Development Length Calculation (ACI 318-11 12.2.3, 12.5)

ψ_e = 1.0 (uncoated hooked bars)

λ = 1.0 (normal weight concrete)

$l_{dh} = 0.02\ \psi_e \frac{f_y}{\lambda \sqrt{F'_c}} d_b = 0.02\ (1.0) \frac{(60000\ \text{psi})}{(1.0) \sqrt{4000\ \text{psi}}} (0.63\ \text{in}) = 11.86\ \text{in}$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): l_{dh} = 8.3 in

8 d_b = 8 (0.63 in) = 5.0 (minimum limit, does not control)

Main vertical stem bars (top end) - Development Length Calculation (ACI 318-11 12.2.3, 12.5)

ψ_t = 1.0 (bars are not horizontal)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (10 in) / 2 = 5 in

cover + d_b / 2 = (2 in) + (0.63 in) / 2 = 2.31 in

c_b = 2.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

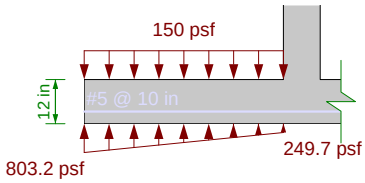
$\frac{c_b + K_{tr}}{d_b} = \frac{(2.31\ \text{in}) + (0.0)}{(0.63\ \text{in})} = 3.70$

$l_d = \left(\frac{3.}{40} \frac{f_y}{\lambda \sqrt{F'_c}} \frac{\psi_t\ \psi_e\ \psi_s}{2.5} \right) d_b = \left[\frac{3.}{40} \frac{(60000\ \text{psi})}{(1.0) \sqrt{4000\ \text{psi}}} \frac{(1.0)\ (1.0)\ (0.80)}{2.5} \right] (0.63\ \text{in}) = 14.23\ \text{in}$

Toe Checks [1.2D + 1.6L + 1.6H]

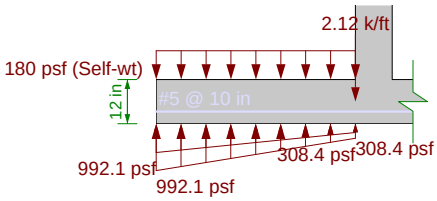
Toe Unfactored Loads

Unfactored Loads



Toe Factored Loads

1.2D + 1.6L + 1.6H



Controlling Moment

Design moment M_u for toe need not exceed moment at stem base:

M_{toe} = 5.91 ft·k / ft < M_{stem} = 6.91 ft·k / ft

M_u = 5.91 ft·k / ft (stem moment does not control)

Flexure Check (ACI 318-11 10.2)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(8.69 \text{ in}) - (0.55 \text{ in}) / 2] = 14.08 \text{ ft·k / ft}$$

ϕM_n = 14.08 ft·k / ft ≥ M_u = 5.91 ft·k / ft ✓

Shear Check (ACI 318-11 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

$$V_c = 2 \lambda \sqrt{F'_c} d = 2 (1.0) \sqrt{4000 \text{ psi}} (8.69 \text{ in}) = 13.19 \text{ k / ft}$$

$$\phi V_n = \phi V_c = (0.750)(13.19 \text{ k / ft}) = 9.89 \text{ k / ft}$$

ϕV_n = 9.89 k / ft ≥ V_u = 1.98 k / ft ✓

Minimum Strain Check (ACI 318-11 10.3.5)

β_1 = 0.850 ($F'_c \le 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(8.69 \text{ in})}{(0.55 \text{ in}) / (0.850)} - 1 \right] = 0.0375$$

ε_t = 0.0375 ≥ 0.004 ✓

Minimum Steel Check (ACI 318-11 10.5.1)

ϕM_n = 14.08 ft·k / ft ≥ (4 / 3) M_u = [4 / 3] (5.91 ft·k / ft) = 7.89 ft·k / ft

Check is waived per ACI 10.5.3 ✓

Shrinkage and Temperature Steel (ACI 318-11 7.12.2)

$$\rho_{ST\_prov} = \frac{A_{ST}}{t \, s_{ST}} = \frac{(0.31 \text{ in}^2 / \text{in})}{(12 \text{ in})(12 \text{ in})} = 0.0022$$

$$\rho_{ST\_min} = \frac{0.0018 (60000)}{f_y} = \frac{0.0018 (60000)}{(60000 \text{ psi})} = 0.0018$$

ρ_{ST_min} = 0.0018

ρ_{ST_prov} = 0.0022 ≥ ρ_{ST_min} = 0.0018 ✓

18 inch limit governs

s_{ST_max} = 18 in

s_{ST} = 12 in ≤ s_{ST_max} = 18 in ✓

Development Check (ACI 318-11 12.12, 12.2.3)

$$\frac{M_u}{\phi M_n} = \frac{(5.91 \text{ ft·k / ft})}{(14.08 \text{ ft·k / ft})} = 0.4199$$ (ratio to represent excess reinforcement)

ψ_t = 1.0 (12 inches or less cast below - 3.00 inches)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (10 in) / 2 = 5 in

cover + d_b / 2 = (3 in) + (0.63 in) / 2 = 3.31 in

c_b = 3.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

$$\frac{c_b + K_{tr}}{d_b} = \frac{(3.31 \text{ in}) + (0.0)}{(0.63 \text{ in})} = 5.30$$

$$l_d = \left(\frac{3.}{40} \frac{f_y}{\lambda \sqrt{F'_c}} \frac{\psi_t \psi_e \psi_s}{2.5} \right) d_b = \left[\frac{3.}{40} \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} \frac{(1.0)(1.0)(0.80)}{2.5} \right] (0.63 \text{ in}) = 14.23 \text{ in}$$

Factoring l_d by the excess reinforcement ratio (0.4199) per 12.2.5: l_d = 5.98 in

12 inch minimum controls

l_{d_prov} = 19 in ≥ l_d = 12 in ✓

Heel Checks [1.2D + 1.6L + 1.6H]

Controlling Moment

Design moment M_u for heel need not exceed moment at stem base:

M_{heel} = 0.69 ft·k / ft < M_{stem} = 6.91 ft·k / ft

M_u = 0.69 ft·k / ft (stem moment does not control)

Shear Check (ACI 318-11 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

Unreinforced, use plain concrete provisions: ACI 22.5.4

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$V_n = \frac{4}{3}\lambda\sqrt{F'_c}\,h = \frac{4}{3}(1.0)\sqrt{4000\ psi}\,(10\ in) = 10.12$ k / ft

ϕ = 0.60

$\phi V_n = \phi\, V_n = (0.60)(10.12$ k / ft) = 6.07 k / ft

ϕV_n = 6.07 k / ft ≥ V_u = 1.38 k / ft ✓

Flexure Check (ACI 318-11 10.2)

Unreinforced, use plain concrete provisions: ACI 22.5.1

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$M_n = 5\sqrt{F'_c}\,S = 5\sqrt{4000\ psi}\,(200\ in^3 / ft) = 5.27$ ft·k / ft (as limited by tension)

$M_n = 0.85\,F'_c\,S = 0.85\,(4000\ psi)\,(200\ in^3 / ft) = 56.67$ ft·k / ft (as limited by compression)

Tension controls

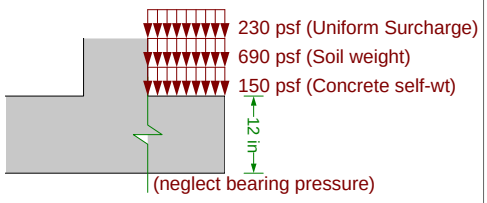
ϕ = 0.60

$\phi M_n = \phi\, M_n = (0.60)(5.27$ ft·k / ft) = 3.16 ft·k / ft

ϕM_n = 3.16 ft·k / ft ≥ M_u = 0.69 ft·k / ft ✓

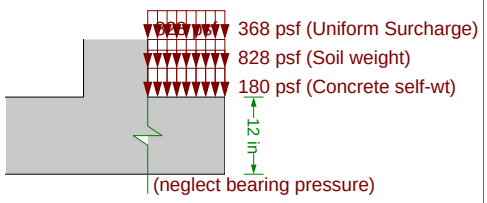
Heel Unfactored Loads

Unfactored Loads



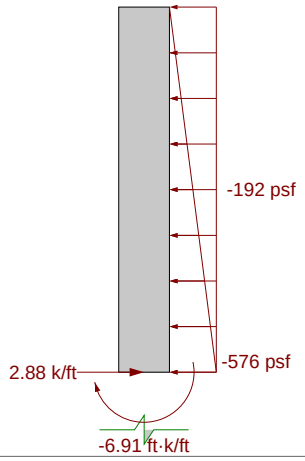
Heel Factored Loads

1.2D + 1.6L + 1.6H

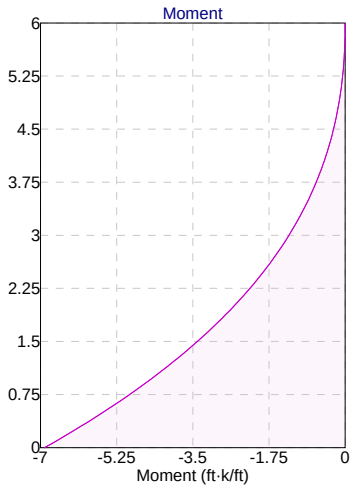


Stem Forces [1.2D + 1.6L + 1.6H]

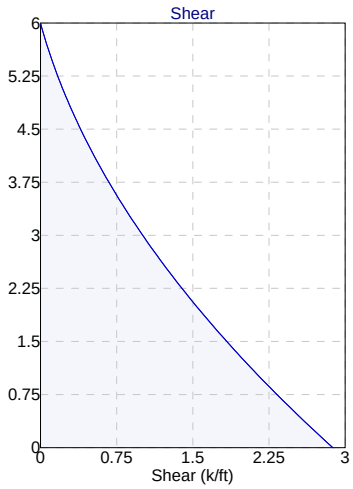
Stem Internal Forces



Stem Internal Forces



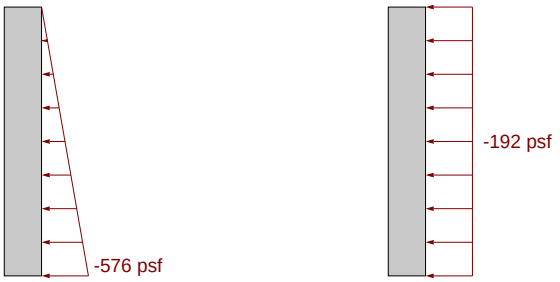
Stem Internal Forces



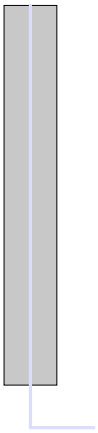
Stem Joint Force Transfer

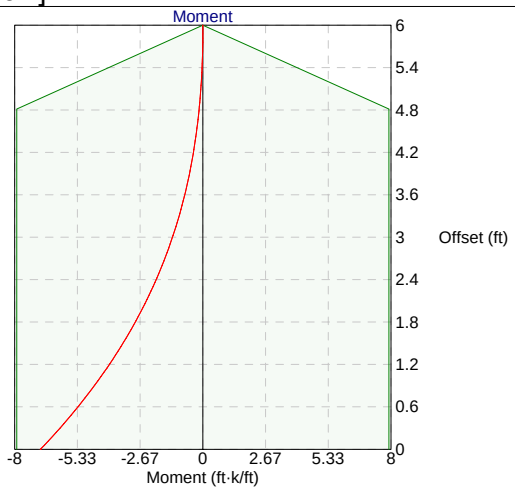
Location	Force
@ stem base	2.88 k/ft

Stem Internal Forces



Stem Moment Checks [1.2D + 1.6L + 1.6H]





Check (ACI 318-11 Ch 10) @ 0 ft from base

ϕM_n = 7.91 ft·k / ft ≥ M_u = 6.91 ft·k / ft ✓

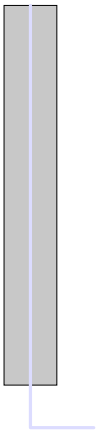
Check (ACI 318-11 Ch 10) @ 4.81 ft from base

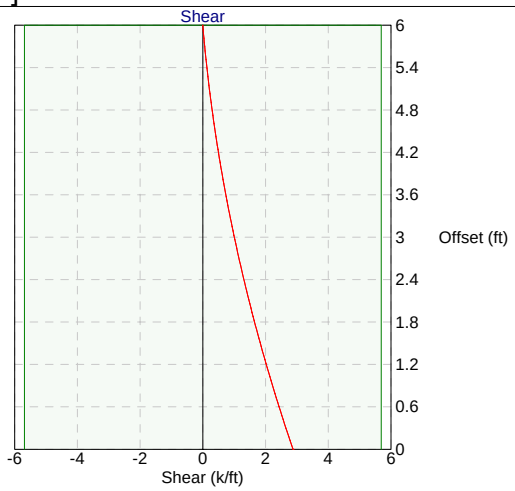
ϕM_n = 7.91 ft·k / ft ≥ M_u = 0.17 ft·k / ft ✓

Check (ACI 318-11 Ch 10) @ 4.85 ft from base

ϕM_n = 7.68 ft·k / ft ≥ M_u = 0.15 ft·k / ft ✓

Stem Shear Checks [1.2D + 1.6L + 1.6H]





Shear Check (ACI 318-11 Ch 11.1.1) @ 0 ft from base

ϕV_n = 5.69 k / ft ≥ V_u = 2.88 k / ft ✓

Stem Miscellaneous Checks [1.2D + 1.6L + 1.6H]

Minimum Steel Check (ACI 318-11 10.5.1) @ 0 ft from base [Stem in negative flexure]

$\phi M_n = 7.91$ ft·k / ft $<$ $(4 / 3) M_u = [4 / 3] (6.91$ ft·k / ft$) = 9.22$ ft·k / ft

$A_{s\_min} = \frac{3\sqrt{F'_c}}{f_y} d = \frac{3\sqrt{4000 \text{ psi}}}{(60000 \text{ psi})} (5 \text{ in}) = 0.02$ in² / in

$200\ d / f_y = 200 (5 \text{ in}) / (60000 \text{ psi}) = 0.02$ in² / in

$A_{s\_min} = 0.02$ in² / in

$A_s = 0.03$ in² / in $\geq$ $A_{s\_min} = 0.02$ in² / in ✓

Minimum Steel Check (ACI 318-11 10.5.1) @ 6 ft from base [Stem in negative flexure]

$\phi M_n = 0$ ft·k / ft $\geq$ $(4 / 3) M_u = [4 / 3] (0$ ft·k / ft$) = 0$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Maximum Steel Check (ACI 318-11 10.3.5) @ 0 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ $(F'_c \leq 4000$ psi$)$

$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in}) (60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55$ in

$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(5 \text{ in})}{(0.55 \text{ in}) / (0.850)} - 1 \right] = 0.0203$

$\varepsilon_t = 0.0203 \geq 0.004$ ✓

Maximum Steel Check (ACI 318-11 10.3.5) @ 6 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ $(F'_c \leq 4000$ psi$)$

$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in}) (60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55$ in

$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(5 \text{ in})}{(0.55 \text{ in}) / (0.850)} - 1 \right] = 0.0203$

$\varepsilon_t = 0.0203 \geq 0.004$ ✓

Wall Horizontal Steel (ACI 318-11 14.3.3, 14.3.5)

$\rho_h = \frac{A_{s\_horz} / s_{horz}}{t} = \frac{(0.31 \text{ in}^2) / (12 \text{ in})}{(10 \text{ in})} = 0.0026$

$\rho_{h\_min} = 0.0020$ (bars No. 5 or less, not less than 60 ksi)

$\rho_h = 0.0026 \geq \rho_{h\_min} = 0.0020$ ✓

$3\ t_{wall} = 3 (10 \text{ in}) = 30$ in

18 inch limit governs

$s_{max} = 18$ in

$s_{horz} = 12$ in $\leq$ $s_{horz\_max} = 18$ in ✓

Development Check (ACI 318-11 12.12, 12.2.3)

$\frac{M_u}{\phi M_n} = \frac{(6.91 \text{ ft·k / ft})}{(7.91 \text{ ft·k / ft})} = 0.8736$ (ratio to represent excess reinforcement)

$\psi_e = 1.0$ (uncoated hooked bars)

$\lambda = 1.0$ (normal weight concrete)

$l_{dh} = 0.02 \psi_e \frac{f_y}{\lambda \sqrt{F'_c}} d_b = 0.02 (1.0) \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} (0.63 \text{ in}) = 11.86$ in

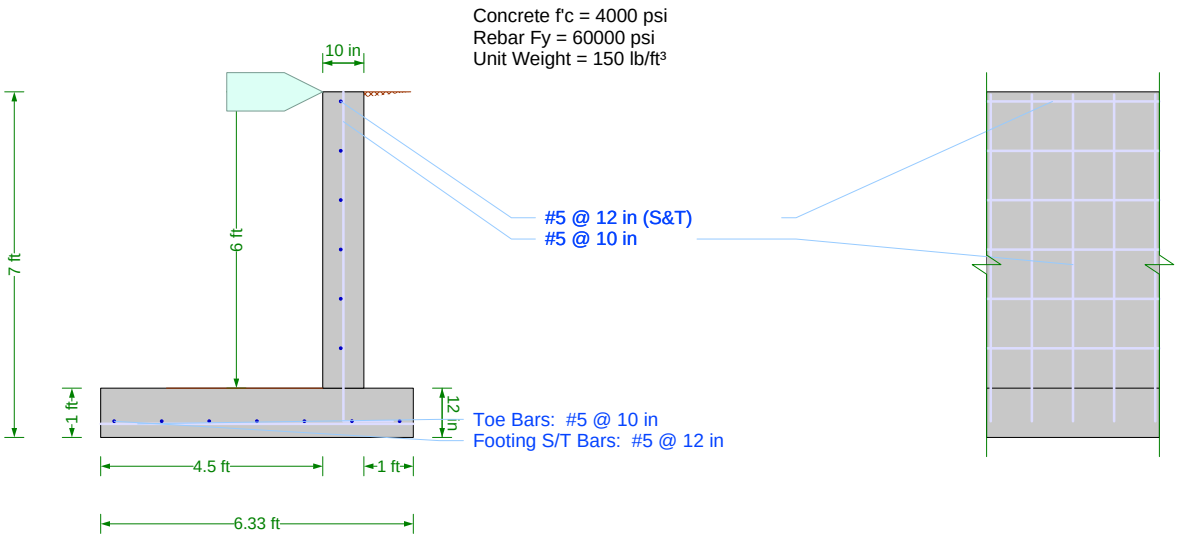
Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): $l_{dh} = 8.3$ in

Factoring l_{dh} by the excess reinforcement ratio (0.8736) per 12.5.3 (d): $l_{dh} = 7.25$ in

$8\ d_b = 8 (0.63 \text{ in}) = 5.0$ (minimum limit, does not control)

$l_{dh\_prov} = 9$ in $\geq$ $l_{dh} = 7.25$ in ✓

Design Detail



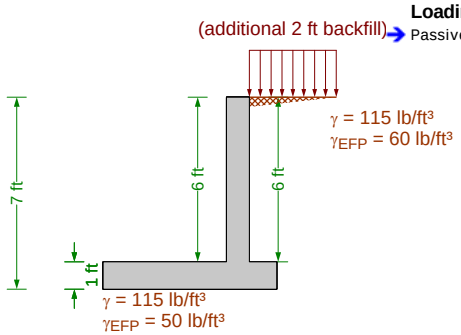
Check Summary

Ratio	Check	Provided	Required	Combination
----- Stability Checks -----				
✓ 0.190	Bearing Pressure	3000 psf	569.7 psf	1.0D + 1.0L + 1.0H
✓ 0.377	Bearing Eccentricity	4.78 in	12.67 in	1.0D + 1.0L + 1.0H
----- Toe Checks -----				
✓ 0.097	Shear	9.89 k/ft	0.95 k/ft	1.2D + 1.6L + 1.6H
✓ 0.160	Moment	14.08 ft·k/ft	2.25 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.107	Min Strain	0.0375	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0.03 in²	0 in²	1.2D + 1.6L + 1.6H
✓ 0.632	Development	19 in	12 in	1.2D + 1.6L + 1.6H
✓ 0.667	S&T Max Spacing	12 in	18 in	1.2D + 1.6L + 1.6H
✓ 0.836	S&T Min Rho	0.0022	0.0018	1.2D + 1.6L + 1.6H
----- Heel Checks -----				
✓ 0.227	Shear	6.07 k/ft	1.38 k/ft	1.2D + 1.6L + 1.6H
✓ 0.218	Moment	3.16 ft·k/ft	0.69 ft·k/ft	1.2D + 1.6L + 1.6H
----- Stem Checks -----				
✓ 0.285	Moment	7.91 ft·k/ft	2.25 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.370	Shear	5.69 k/ft	2.1 k/ft	1.2D + 1.6L + 1.6H
✓ 0.197	Max Steel	0.0203	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0 in²/in	0 in²/in	1.2D + 1.6L + 1.6H
✓ 0.667	Base Development	9 in	6 in	1.2D + 1.6L + 1.6H
✓ 0.774	Horz Bar Rho	0.0026	0.0020	1.2D + 1.6L + 1.6H
✓ 0.667	Horz Bar Spacing	12 in	18 in	1.2D + 1.6L + 1.6H

Criteria

Building Code	IBC 2012
Concrete Load Combs	IBC 2012 (Strength)
Masonry Load Combs	ASCE 7-10 (ASD)
Stability Load Combs	ASCE 7-10 (ASD)
Restrained Against Sliding	Yes
Neglect Bearing At Heel	Yes
Use Vert. Comp. for OT	No
Use Vert. Comp. for Sliding	No
Use Vert. Comp. for Bearing	Yes
Use Surcharge for Sliding & OT	Yes
Use Surcharge for Bearing	Yes
Neglect Soil Over Toe	No
Neglect Backfill Wt. for Coulomb	No
Factor Soil Weight As Dead	Yes
Use Passive Force for OT	Yes
Assume Pressure To Top	Yes
Extend Backfill Pressure To Key Bottom	No
Use Toe Passive Pressure for Bearing	No
Required F.S. for OT	1.50
Required F.S. for Sliding	1.50
Has Different Safety Factors for Seismic	No
Allowable Bearing Pressure	3000 psf
Req'd Bearing Location	Middle third
Wall Friction Angle	25°
Friction Coefficent	0.35
Soil Reaction Modulus	172800 lb/ft³

Loads



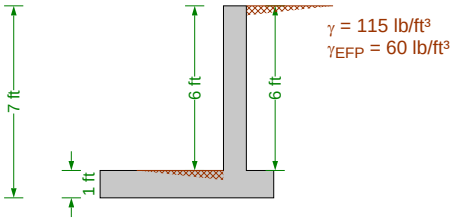
Load Combinations

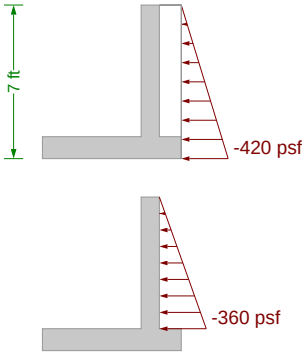
IBC 2012 (Strength)

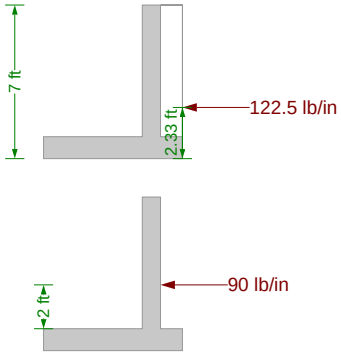
1.2D + 1.6L + 1.6H
1.2D + 1.6L + 0.9H
1.2D + 0.5L + 1.6H
1.2D + 0.5L + 0.9H
1.2D + 1.6H
1.2D + 0.9H
0.9D + 1.6H
0.9D + 0.9H
1.4D

Emerald Sky Dairy 6ft Wall

Backfill Pressure







Lateral Earth Pressure

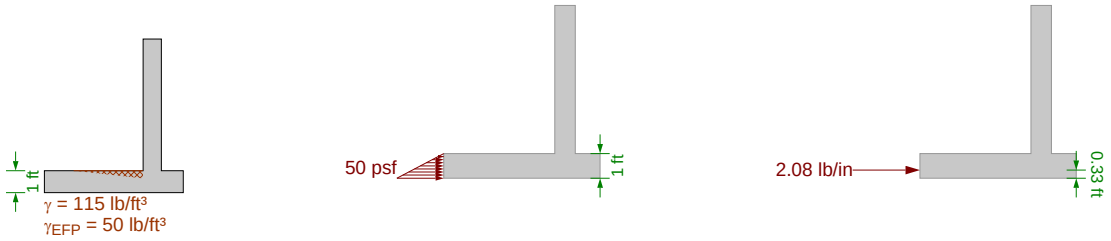
Equivalent Fluid Pressure

$\sigma_h = H\,\gamma_{fluid}$ = (7 ft)(60 lb / ft³) = 420 psf

Lateral Earth Pressure (stem only)

$\sigma_h = H\,\gamma_{fluid}$ = (6 ft)(60 lb / ft³) = 360 psf

Passive Pressure

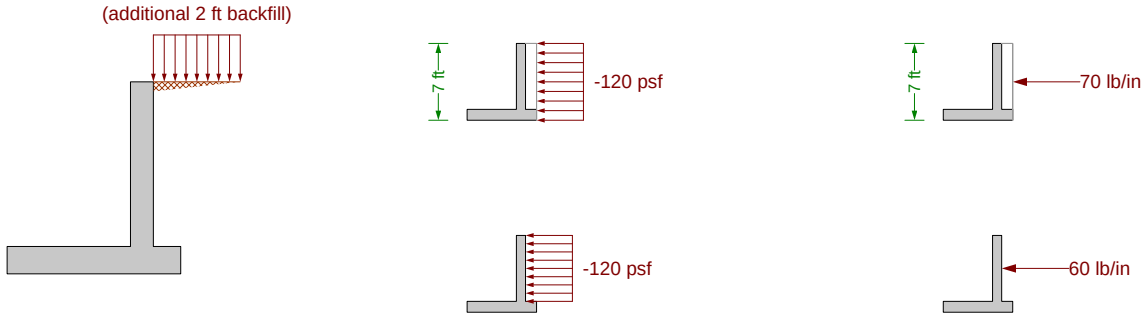


Lateral Earth Pressure

Equivalent Fluid Pressure

$\sigma_h = H\ \gamma_{fluid} = (1\ ft)(50\ lb / ft^3) = 50\ psf$

Uniform Surcharge Pressure



Lateral Surcharge Pressure

$q = \gamma\ H_{sur} = (115\ lb / ft^3)(2\ ft) = 230\ psf$

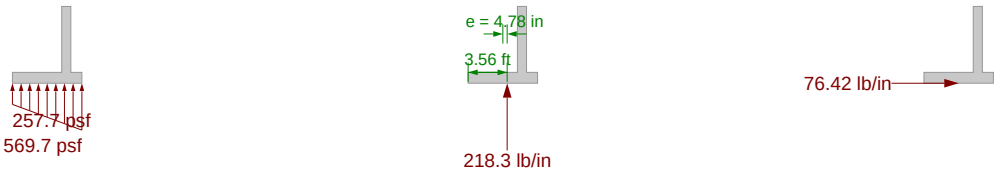
Equivalent Fluid Pressure

$K = \frac{\gamma_{fluid}}{\gamma} = \frac{(60\ lb / ft^3)}{(115\ lb / ft^3)} = 0.5217$

$\sigma_{sur} = K\ q = (0.5217)(230\ psf) = 120\ psf$

Wall/Soil Weights

Bearing Pressure



Friction

$F = \mu R = (0.350)(218.3 \text{ lb / in}) = 76.42 \text{ lb / in}$

Bearing Pressure Calculation

Contributing Forces

	Vert Force	...offset	Horz Force	...offset	OT Moment
Backfill Pressure	-0 lb/in	-	0 lb/in	-	-0 in·lb/ft
Uniform Surcharge Pressure	-19.17 lb/in	5.83 ft	0 lb/in	-	-16100 in·lb/ft
Footing Weight	-79.17 lb/in	3.17 ft	0 lb/in	-	-36100 in·lb/ft
Stem Weight	-62.5 lb/in	4.92 ft	0 lb/in	-	-44250 in·lb/ft
Backfill Weight	-57.5 lb/in	5.83 ft	0 lb/in	-	-48300 in·lb/ft
Soil over toe Weight	-0 lb/in	-	0 lb/in	-	-0 in·lb/ft
Stem Base Shear	-0 lb/in	-	-109.56 lb/in	1 ft	15777 in·lb/ft
Stem Base Moment	0 lb/in	-	0 lb/in	-	16901 in·lb/ft
	-218.33 lb/in				-112072.49 in·lb/ft

$$\frac{-112072.49 \text{ in·lb / ft}}{-218.33 \text{ lb / in}} = 3.56 \text{ ft}$$

Stability Checks [1.0D + 1.0L + 1.0H]

Overturning Check

Check not performed; wall has lateral support.

Sliding Check

Check not performed; restrained against sliding.

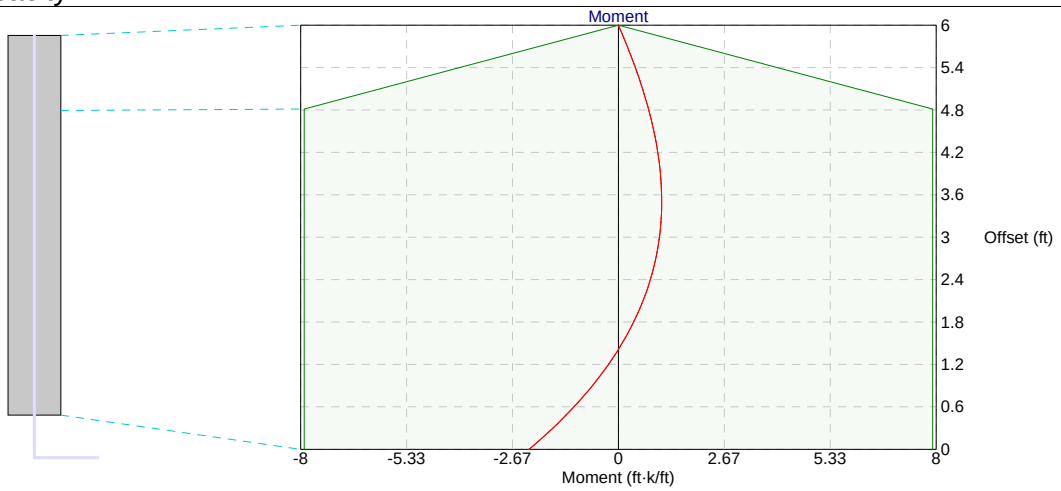
Bearing Capacity Check

Bearing pressure < allowable (569.7 psf < 3000 psf) - OK
Bearing resultant eccentricity < allowable (4.78 in < 12.67 in) - OK

Wall Top Displacement

Not calculated because this wall has a lateral restraint.

Stem Flexural Capacity



Capacity (ACI 318-11 10.2) @ 0 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 0 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 4.81 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 4.81 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0.55 \text{ in}) / 2] = 7.91 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 6 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

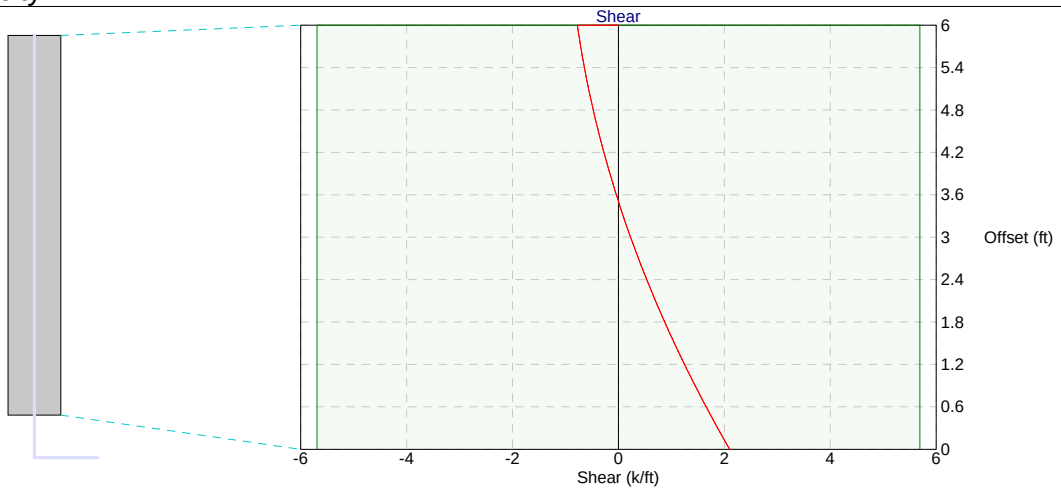
$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Capacity (ACI 318-11 10.2) @ 6 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(5 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Stem Shear Capacity



Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 0 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 0 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 6 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Shear Capacity (ACI 318-11 11.1.1, 11.2.1) @ 6 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(5\ in) = 7.59\ k / ft$

$\phi V_n = \phi V_c = (0.750)\,(7.59\ k / ft) = 5.69\ k / ft$

Stem Development/Lap Length Calculations

Main vertical stem bars (bottom end) - Development Length Calculation (ACI 318-11 12.2.3, 12.5)

ψ_e = 1.0 (uncoated hooked bars)

λ = 1.0 (normal weight concrete)

$l_{dh} = 0.02\ \psi_e \frac{f_y}{\lambda \sqrt{F'_c}} d_b = 0.02\ (1.0) \frac{(60000\ \text{psi})}{(1.0) \sqrt{4000\ \text{psi}}} (0.63\ \text{in}) = 11.86\ \text{in}$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): l_{dh} = 8.3 in

8 d_b = 8 (0.63 in) = 5.0 (minimum limit, does not control)

Main vertical stem bars (top end) - Development Length Calculation (ACI 318-11 12.2.3, 12.5)

ψ_t = 1.0 (bars are not horizontal)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (10 in) / 2 = 5 in

cover + d_b / 2 = (2 in) + (0.63 in) / 2 = 2.31 in

c_b = 2.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

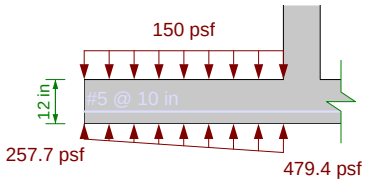
$\frac{c_b + K_{tr}}{d_b} = \frac{(2.31\ \text{in}) + (0.0)}{(0.63\ \text{in})} = 3.70$

$l_d = \left(\frac{3.}{40} \frac{f_y}{\lambda \sqrt{F'_c}} \frac{\psi_t\ \psi_e\ \psi_s}{2.5} \right) d_b = \left[\frac{3.}{40} \frac{(60000\ \text{psi})}{(1.0) \sqrt{4000\ \text{psi}}} \frac{(1.0)\ (1.0)\ (0.80)}{2.5} \right] (0.63\ \text{in}) = 14.23\ \text{in}$

Toe Checks [1.2D + 1.6L + 1.6H]

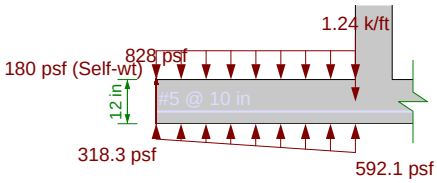
Toe Unfactored Loads

Unfactored Loads



Toe Factored Loads

1.2D + 1.6L + 1.6H



Controlling Moment

Design moment M_u for toe need not exceed moment at stem base:

M_{toe} = 2.32 ft·k / ft ≥ M_{stem} = 2.25 ft·k / ft

M_u = 2.25 ft·k / ft (stem base moment controls)

Flexure Check (ACI 318-11 10.2)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(8.69 \text{ in}) - (0.55 \text{ in}) / 2] = 14.08 \text{ ft·k / ft}$$

ϕM_n = 14.08 ft·k / ft ≥ M_u = 2.25 ft·k / ft ✓

Shear Check (ACI 318-11 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

$$V_c = 2 \lambda \sqrt{F'_c}\, d = 2 (1.0) \sqrt{4000 \text{ psi}}\, (8.69 \text{ in}) = 13.19 \text{ k / ft}$$

$$\phi V_n = \phi V_c = (0.750)(13.19 \text{ k / ft}) = 9.89 \text{ k / ft}$$

ϕV_n = 9.89 k / ft ≥ V_u = 0.95 k / ft ✓

Minimum Strain Check (ACI 318-11 10.3.5)

β_1 = 0.850 ($F'_c \le 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(8.69 \text{ in})}{(0.55 \text{ in}) / (0.850)} - 1 \right] = 0.0375$$

ε_t = 0.0375 ≥ 0.004 ✓

Minimum Steel Check (ACI 318-11 10.5.1)

ϕM_n = 14.08 ft·k / ft ≥ (4 / 3) M_u = [4 / 3] (2.25 ft·k / ft) = 3 ft·k / ft

Check is waived per ACI 10.5.3 ✓

Shrinkage and Temperature Steel (ACI 318-11 7.12.2)

$$\rho_{ST\_prov} = \frac{A_{ST}}{t\, s_{ST}} = \frac{(0.31 \text{ in}^2 / \text{in})}{(12 \text{ in})(12 \text{ in})} = 0.0022$$

$$\rho_{ST\_min} = \frac{0.0018 (60000)}{f_y} = \frac{0.0018 (60000)}{(60000 \text{ psi})} = 0.0018$$

ρ_{ST_min} = 0.0018

ρ_{ST_prov} = 0.0022 ≥ ρ_{ST_min} = 0.0018 ✓

18 inch limit governs

s_{ST_max} = 18 in

s_{ST} = 12 in ≤ s_{ST_max} = 18 in ✓

Development Check (ACI 318-11 12.12, 12.2.3)

$$\frac{M_u}{\phi M_n} = \frac{(2.25 \text{ ft·k / ft})}{(14.08 \text{ ft·k / ft})} = 0.160$$ (ratio to represent excess reinforcement)

ψ_t = 1.0 (12 inches or less cast below - 3.00 inches)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (10 in) / 2 = 5 in

cover + d_b / 2 = (3 in) + (0.63 in) / 2 = 3.31 in

c_b = 3.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

$$\frac{c_b + K_{tr}}{d_b} = \frac{(3.31 \text{ in}) + (0.0)}{(0.63 \text{ in})} = 5.30$$

$$l_d = \left(\frac{3.}{40} \frac{f_y}{\lambda \sqrt{F'_c}} \frac{\psi_t \psi_e \psi_s}{2.5} \right) d_b = \left[\frac{3.}{40} \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} \frac{(1.0)(1.0)(0.80)}{2.5} \right] (0.63 \text{ in}) = 14.23 \text{ in}$$

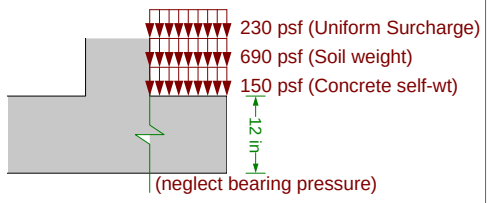
Factoring l_d by the excess reinforcement ratio (0.1600) per 12.2.5: l_d = 2.28 in

12 inch minimum controls

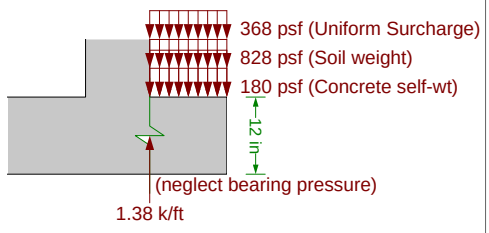
l_{d_prov} = 19 in ≥ l_d = 12 in ✓

Heel Checks [1.2D + 1.6L + 1.6H]

Heel Unfactored Loads



Heel Factored Loads



Controlling Moment

Design moment M_u for heel need not exceed moment at stem base:

M_{heel} = 0.69 ft·k / ft < M_{stem} = 2.25 ft·k / ft

M_u = 0.69 ft·k / ft (stem moment does not control)

Shear Check (ACI 318-11 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

Unreinforced, use plain concrete provisions: ACI 22.5.4

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$V_n = \frac{4}{3}\lambda\sqrt{F'_c}\,h = \frac{4}{3}(1.0)\sqrt{4000\text{ psi}}(10\text{ in}) = 10.12$ k / ft

ϕ = 0.60

$\phi V_n = \phi V_n = (0.60)(10.12\text{ k / ft}) = 6.07$ k / ft

ϕV_n = 6.07 k / ft ≥ V_u = 1.38 k / ft ✓

Flexure Check (ACI 318-11 10.2)

Unreinforced, use plain concrete provisions: ACI 22.5.1

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$M_n = 5\sqrt{F'_c}\,S = 5\sqrt{4000\text{ psi}}(200\text{ in}^3\text{ / ft}) = 5.27$ ft·k / ft (as limited by tension)

$M_n = 0.85\,F'_c\,S = 0.85(4000\text{ psi})(200\text{ in}^3\text{ / ft}) = 56.67$ ft·k / ft (as limited by compression)

Tension controls

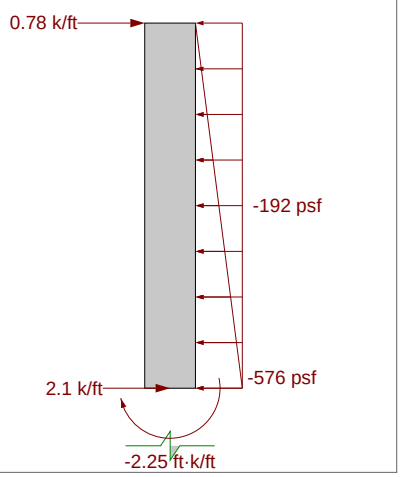
ϕ = 0.60

$\phi M_n = \phi M_n = (0.60)(5.27\text{ ft·k / ft}) = 3.16$ ft·k / ft

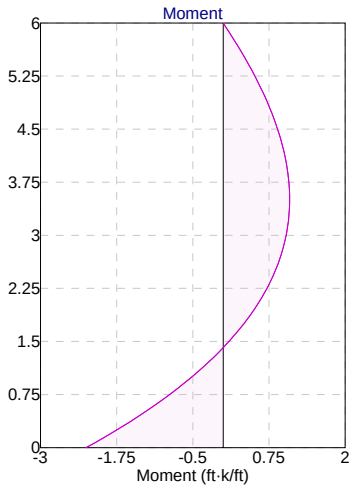
ϕM_n = 3.16 ft·k / ft ≥ M_u = 0.69 ft·k / ft ✓

Stem Forces [1.2D + 1.6L + 1.6H]

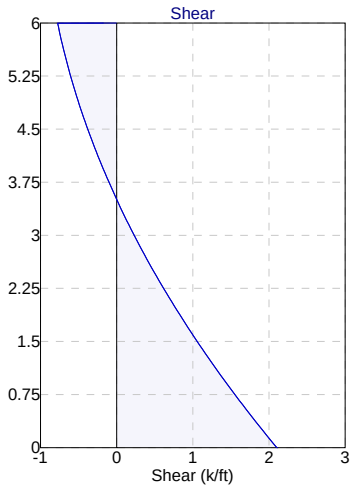
Stem Internal Forces



Stem Internal Forces



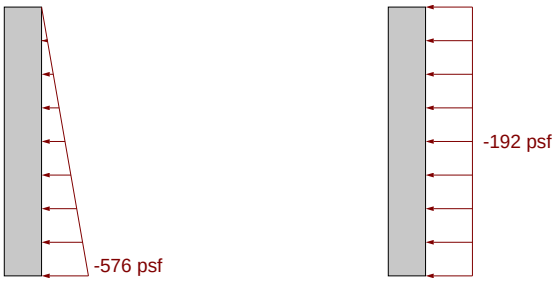
Stem Internal Forces



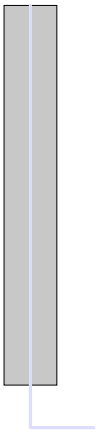
Stem Joint Force Transfer

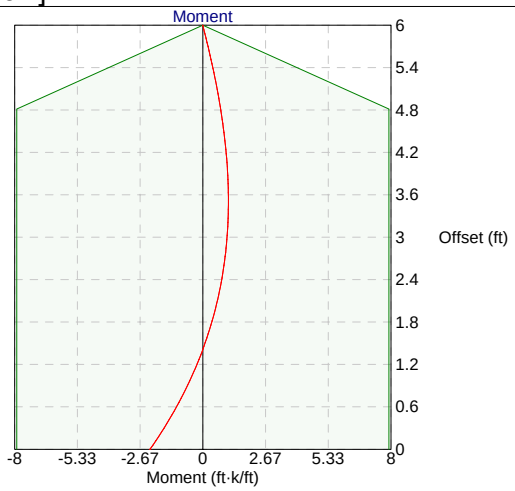
Location	Force
@ stem base	2.1 k/ft

Stem Internal Forces



Stem Moment Checks [1.2D + 1.6L + 1.6H]





Check (ACI 318-11 Ch 10) @ 3.52 ft from base [Positive bending]

ϕM_n = 7.91 ft·k / ft ≥ M_u = 1.09 ft·k / ft ✓

Check (ACI 318-11 Ch 10) @ 4.81 ft from base [Positive bending]

ϕM_n = 7.91 ft·k / ft ≥ M_u = 0.77 ft·k / ft ✓

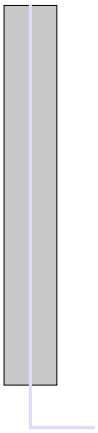
Check (ACI 318-11 Ch 10) @ 4.85 ft from base [Positive bending]

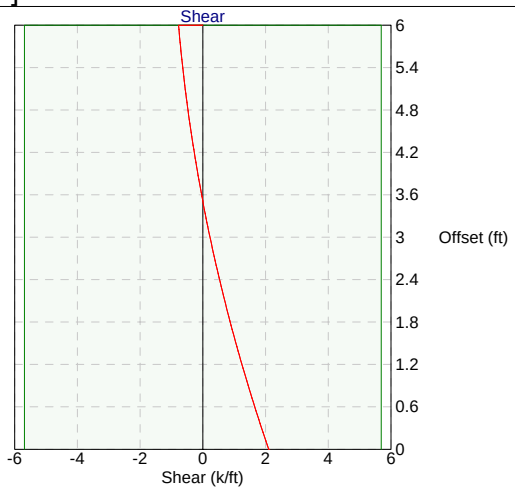
ϕM_n = 7.68 ft·k / ft ≥ M_u = 0.74 ft·k / ft ✓

Check (ACI 318-11 Ch 10) @ 0 ft from base [Negative bending]

ϕM_n = 7.91 ft·k / ft ≥ M_u = 2.25 ft·k / ft ✓

Stem Shear Checks [1.2D + 1.6L + 1.6H]





Shear Check (ACI 318-11 Ch 11.1.1) @ 0 ft from base [Positive shear]

ϕV_n = 5.69 k / ft ≥ V_u = 2.1 k / ft ✓

Shear Check (ACI 318-11 Ch 11.1.1) @ 6 ft from base [Negative shear]

ϕV_n = 5.69 k / ft ≥ V_u = 0.78 k / ft ✓

Stem Miscellaneous Checks [1.2D + 1.6L + 1.6H]

Minimum Steel Check (ACI 318-11 10.5.1) @ 0 ft from base [Stem in negative flexure]

$\phi M_n = 7.91$ ft·k / ft $\geq (4 / 3) M_u = [4 / 3] (2.25$ ft·k / ft$) = 3$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Minimum Steel Check (ACI 318-11 10.5.1) @ 6 ft from base [Stem in negative flexure]

$\phi M_n = 0$ ft·k / ft $\geq (4 / 3) M_u = [4 / 3] (0$ ft·k / ft$) = 0$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Maximum Steel Check (ACI 318-11 10.3.5) @ 0 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ ($F'_c \leq 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in}) (60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(5 \text{ in})}{(0.55 \text{ in}) / (0.850)} - 1 \right] = 0.0203$$

$\varepsilon_t = 0.0203 \geq 0.004$ ✓

Maximum Steel Check (ACI 318-11 10.3.5) @ 6 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ ($F'_c \leq 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in}) (60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.55 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(5 \text{ in})}{(0.55 \text{ in}) / (0.850)} - 1 \right] = 0.0203$$

$\varepsilon_t = 0.0203 \geq 0.004$ ✓

Wall Horizontal Steel (ACI 318-11 14.3.3, 14.3.5)

$$\rho_h = \frac{A_{s\_horz} / s_{horz}}{t} = \frac{(0.31 \text{ in}^2) / (12 \text{ in})}{(10 \text{ in})} = 0.0026$$

$\rho_{h\_min} = 0.0020$ (bars No. 5 or less, not less than 60 ksi)

$\rho_h = 0.0026 \geq \rho_{h\_min} = 0.0020$ ✓

$3 t_{wall} = 3 (10 \text{ in}) = 30$ in

18 inch limit governs

$s_{max} = 18$ in

$s_{horz} = 12$ in $\leq s_{horz\_max} = 18$ in ✓

Development Check (ACI 318-11 12.12, 12.2.3)

$\frac{M_u}{\phi M_n} = \frac{(2.25 \text{ ft·k / ft})}{(7.91 \text{ ft·k / ft})} = 0.2848$ (ratio to represent excess reinforcement)

$\psi_e = 1.0$ (uncoated hooked bars)

$\lambda = 1.0$ (normal weight concrete)

$$l_{dh} = 0.02 \psi_e \frac{f_y}{\lambda \sqrt{F'_c}} d_b = 0.02 (1.0) \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} (0.63 \text{ in}) = 11.86 \text{ in}$$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): $l_{dh} = 8.3$ in

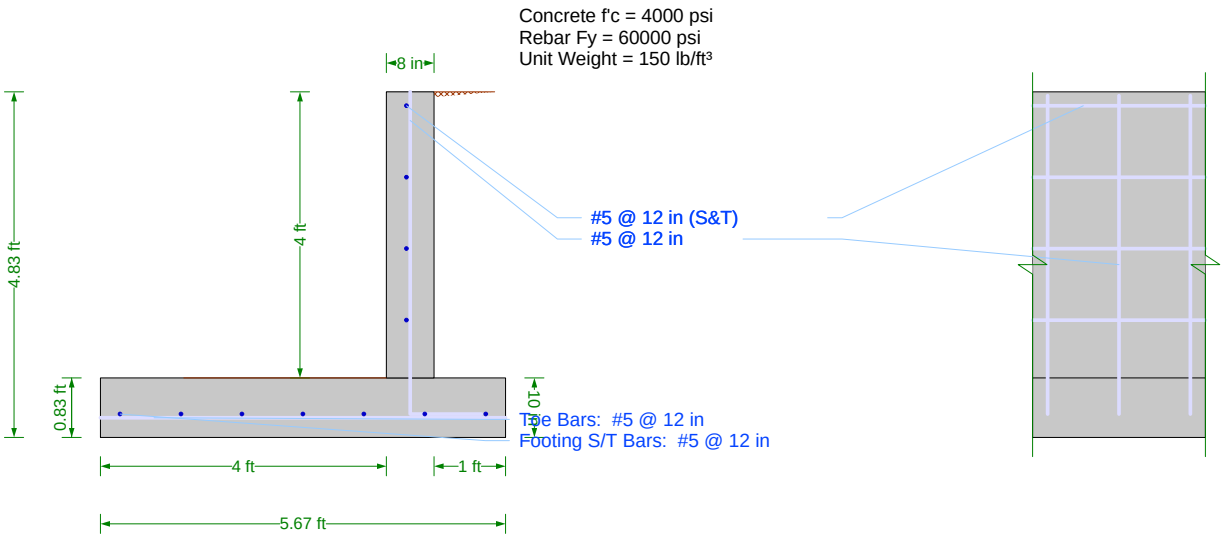
Factoring l_{dh} by the excess reinforcement ratio (0.2848) per 12.5.3 (d): $l_{dh} = 2.36$ in

$8 d_b = 8 (0.63 \text{ in}) = 5.0$ (minimum limit, does not control)

6 inch minimum controls

$l_{dh\_prov} = 9$ in $\geq l_{dh} = 6$ in ✓

Design Detail



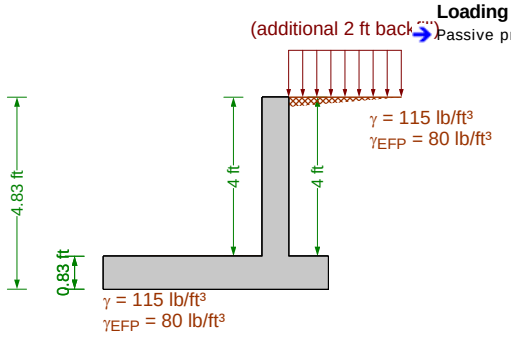
Check Summary

Ratio	Check	Provided	Required	Combination
----- Stability Checks -----				
✓ 0.784	Overturning	2.17	1.70	1.0D + 1.0L + 1.0H
✓ 0.178	Bearing Pressure	3000 psf	534.9 psf	1.0D + 1.0L + 1.0H
✓ 0.686	Bearing Eccentricity	7.77 in	11.33 in	1.0D + 1.0L + 1.0H
----- Toe Checks -----				
✓ 0.160	Shear	7.61 k/ft	1.22 k/ft	1.2D + 1.6L + 1.6H
✓ 0.347	Moment	9.01 ft·k/ft	3.13 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.116	Min Strain	0.0344	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0.03 in²	0 in²	1.2D + 1.6L + 1.6H
✓ 0.706	Development	17 in	12 in	1.2D + 1.6L + 1.6H
✓ 0.667	S&T Max Spacing	12 in	18 in	1.2D + 1.6L + 1.6H
✓ 0.697	S&T Min Rho	0.0026	0.0018	1.2D + 1.6L + 1.6H
----- Heel Checks -----				
✓ 0.220	Shear	4.86 k/ft	1.07 k/ft	1.2D + 1.6L + 1.6H
✓ 0.264	Moment	2.02 ft·k/ft	0.54 ft·k/ft	1.2D + 1.6L + 1.6H
----- Stem Checks -----				
✓ 0.649	Moment	5.26 ft·k/ft	3.41 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.450	Shear	4.55 k/ft	2.05 k/ft	1.2D + 1.6L + 1.6H
✓ 0.206	Max Steel	0.0194	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0 in²/in	0 in²/in	1.2D + 1.6L + 1.6H
✓ 0.857	Base Development	7 in	6 in	1.2D + 1.6L + 1.6H
✓ 0.619	Horz Bar Rho	0.0032	0.0020	1.2D + 1.6L + 1.6H
✓ 0.667	Horz Bar Spacing	12 in	18 in	1.2D + 1.6L + 1.6H

Criteria

Building Code	IBC 2009
Concrete Load Combs	IBC 2009 (Strength)
Masonry Load Combs	ASCE 7-10 (ASD)
Stability Load Combs	ASCE 7-10 (ASD)
Restrained Against Sliding	Yes
Neglect Bearing At Heel	Yes
Use Vert. Comp. for OT	No
Use Vert. Comp. for Sliding	No
Use Vert. Comp. for Bearing	Yes
Use Surcharge for Sliding & OT	Yes
Use Surcharge for Bearing	Yes
Neglect Soil Over Toe	No
Neglect Backfill Wt. for Coulomb	No
Factor Soil Weight As Dead	Yes
Use Passive Force for OT	Yes
Assume Pressure To Top	Yes
Extend Backfill Pressure To Key Bottom	No
Use Toe Passive Pressure for Bearing	No
Required F.S. for OT	1.70
Required F.S. for Sliding	1.70
Has Different Safety Factors for Seismic	No
Allowable Bearing Pressure	3000 psf
Req'd Bearing Location	Middle third
Wall Friction Angle	25°
Friction Coefficent	0.35
Soil Reaction Modulus	172800 lb/ft³

Loads

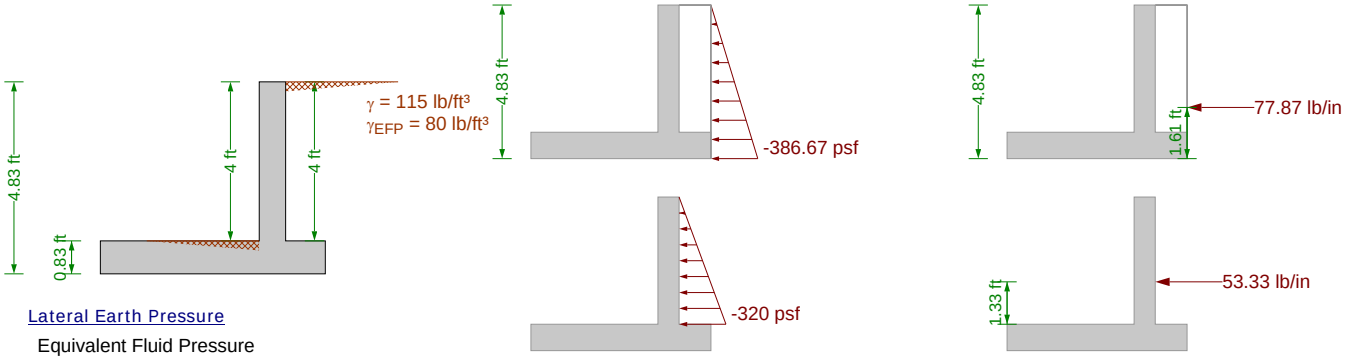


Load Combinations

IBC 2009 (Strength)

1.2D + 1.6L + 1.6H
1.2D + 0.5L
0.9D + 1.6H
1.4D
1.2D

Backfill Pressure



Lateral Earth Pressure

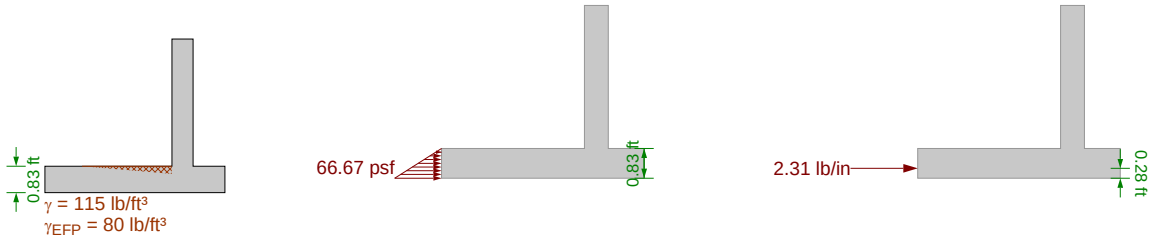
Equivalent Fluid Pressure

$\sigma_h = H\,\gamma_{fluid}$ = (4.83 ft)(80 lb / ft³) = 386.7 psf

Lateral Earth Pressure (stem only)

$\sigma_h = H\,\gamma_{fluid}$ = (4 ft)(80 lb / ft³) = 320 psf

Passive Pressure

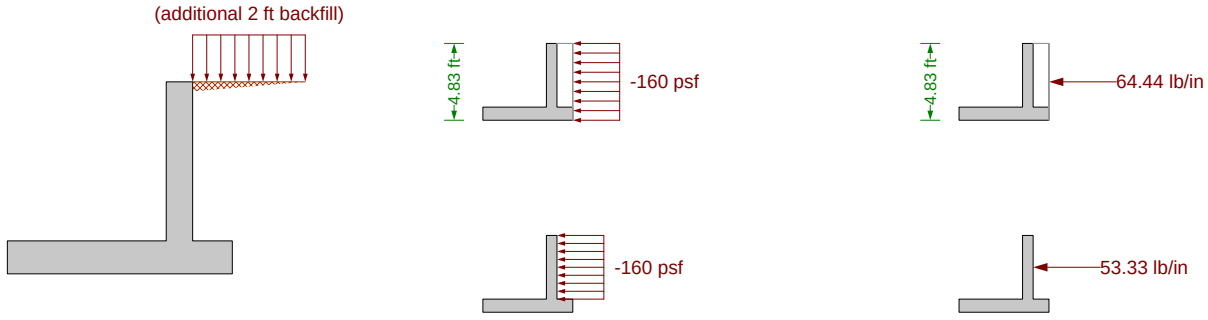


Lateral Earth Pressure

Equivalent Fluid Pressure

$\sigma_h = H\,\gamma_{fluid} = (0.83\text{ ft})(80\text{ lb / ft}^3) = 66.67\text{ psf}$

Uniform Surcharge Pressure



Lateral Surcharge Pressure

$q = \gamma\,H_{sur} = (115\text{ lb / ft}^3)(2\text{ ft}) = 230\text{ psf}$

Equivalent Fluid Pressure

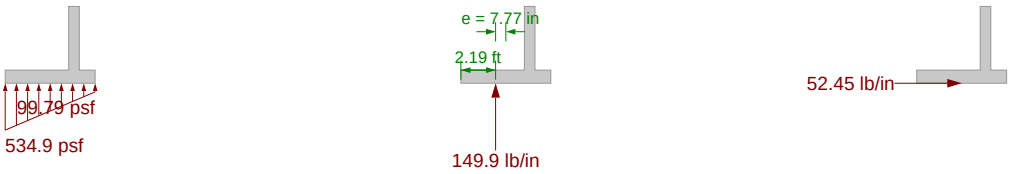
$K = \frac{\gamma_{fluid}}{\gamma} = \frac{(80\text{ lb / ft}^3)}{(115\text{ lb / ft}^3)} = 0.6957$

$\sigma_{sur} = K\,q = (0.6957)(230\text{ psf}) = 160\text{ psf}$

Emerald Sky Dairy, LLC 0-4ft Wall

Wall/Soil Weights

Bearing Pressure



Friction

$F = \mu R = (0.350)(149.9\ lb/in) = 52.45\ lb/in$

Bearing Pressure Calculation

Contributing Forces

	Vert Force	...offset	Horz Force	...offset	OT Moment
Backfill Pressure	-0 lb/in	-	-77.87 lb/in	1.61 ft	18066 in·lb/ft
Uniform Surcharge Pressure	-19.17 lb/in	5.17 ft	-64.44 lb/in	2.42 ft	8167 in·lb/ft
Footing Weight	-59.03 lb/in	2.83 ft	0 lb/in	-	-24083.33 in·lb/ft
Stem Weight	-33.33 lb/in	4.33 ft	0 lb/in	-	-20800 in·lb/ft
Backfill Weight	-38.33 lb/in	5.17 ft	0 lb/in	-	-28520 in·lb/ft
Soil over toe Weight	-0 lb/in	-	0 lb/in	-	-0 in·lb/ft
	-149.86 lb/in				-47170.74 in·lb/ft

$$\frac{-47170.74\ in{\cdot}lb/ft}{-149.86\ lb/in} = 2.19\ ft$$

Stability Checks [1.0D + 1.0L + 1.0H]

Overturning Check

Overturning Moments

	Force	Distance	Moment
Backfill pressure (horz)	77.87 lb/in	1.61 ft	18066 in·lb/ft
Surcharge (uniform) lateral pressure	64.44 lb/in	2.42 ft	22427 in·lb/ft
		Total:	40493 in·lb/ft

Resisting Moments

	Force	Distance	Moment
Surcharge (uniform) vertical pressure	19.17 lb/in	5.17 ft	14260 in·lb/ft
Passive pressure @ toe	2.31 lb/in	0.28 ft	92.59 in·lb/ft
Footing Weight	-59.03 lb/in	2.83 ft	24083 in·lb/ft
Stem Weight	-33.33 lb/in	4.33 ft	20800 in·lb/ft
Backfill Weight	-38.33 lb/in	5.17 ft	28520 in·lb/ft
Soil over toe Weight	-0 lb/in	2 ft	0 in·lb/ft
		Total:	87756 in·lb/ft

$$F.S. = \frac{RM}{OTM} = \frac{87756 \text{ in·lb / ft}}{40493 \text{ in·lb / ft}} = 2.167 > 1.70 \text{ (OK)}$$

Sliding Check

Check not performed; restrained against sliding.

Bearing Capacity Check

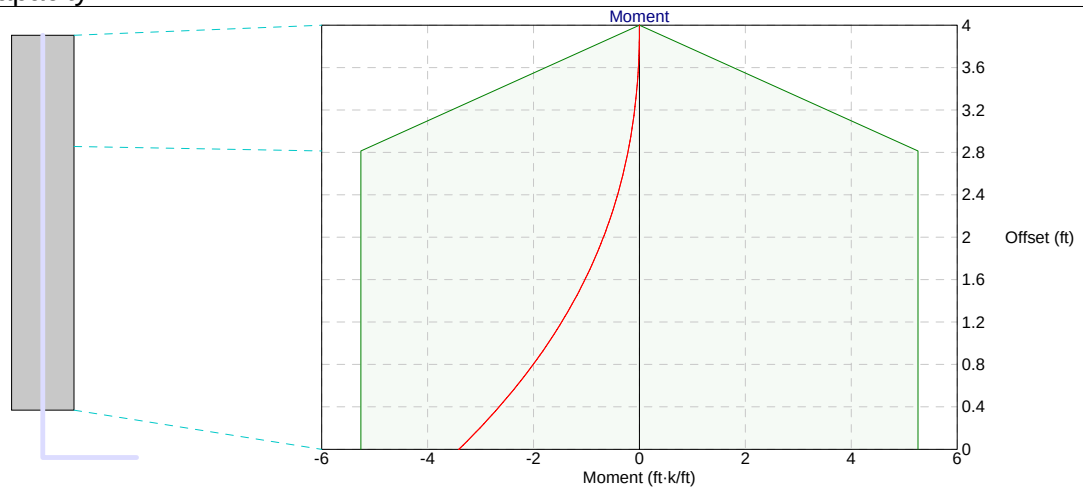
Bearing pressure < allowable (534.9 psf < 3000 psf) - OK
Bearing resultant eccentricity < allowable (7.77 in < 11.33 in) - OK

Wall Top Displacement

(based on unfactored service loads)

Deflection due to stem flexural displacement	0.007 in
Deflection due to rotation from settlement	0.021 in
Total deflection at top of wall (positive towards toe)	0.029 in

Stem Flexural Capacity



Capacity (ACI 318-08 10.2) @ 0 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 0 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 2.81 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 2.81 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 4 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

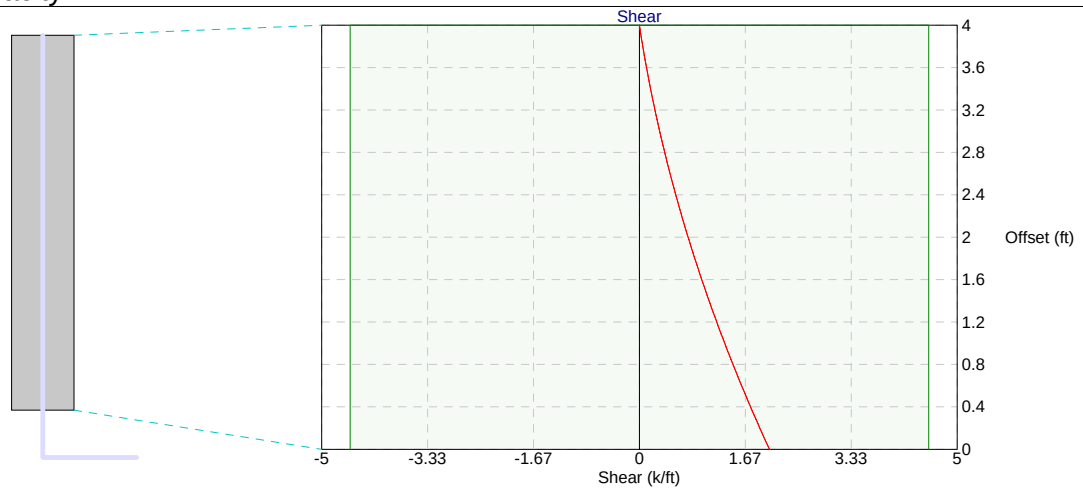
$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 4 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Stem Shear Capacity



Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 0 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)(6.07\ k/ft) = 4.55\ k/ft$

Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 0 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)(6.07\ k/ft) = 4.55\ k/ft$

Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 4 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)(6.07\ k/ft) = 4.55\ k/ft$

Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 4 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)(6.07\ k/ft) = 4.55\ k/ft$

Stem Development/Lap Length Calculations

Main vertical stem bars (bottom end) - Development Length Calculation (ACI 318-08 12.2.3, 12.5)

ψ_e = 1.0 (uncoated hooked bars)

λ = 1.0 (normal weight concrete)

$$l_{dh} = 0.02\,\psi_e \frac{f_y}{\lambda\sqrt{F'_c}}\,d_b = 0.02\,(1.0)\frac{(60000\text{ psi})}{(1.0)\sqrt{4000\text{ psi}}}(0.63\text{ in}) = 11.86\text{ in}$$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): l_{dh} = 8.3 in

8 d_b = 8 (0.63 in) = 5.0 (minimum limit, does not control)

Main vertical stem bars (top end) - Development Length Calculation (ACI 318-08 12.2.3, 12.5)

ψ_t = 1.0 (bars are not horizontal)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (12 in) / 2 = 6 in

cover + d_b / 2 = (2 in) + (0.63 in) / 2 = 2.31 in

c_b = 2.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

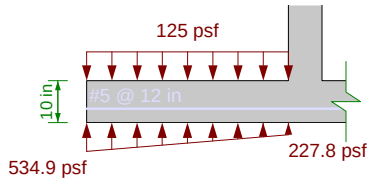
$$\frac{c_b + K_{tr}}{d_b} = \frac{(2.31\text{ in}) + (0.0)}{(0.63\text{ in})} = 3.70$$

$$l_d = \left(\frac{3.}{40}\frac{f_y}{\lambda\sqrt{F'_c}}\frac{\psi_t\,\psi_e\,\psi_s}{2.5}\right)d_b = \left[\frac{3.}{40}\frac{(60000\text{ psi})}{(1.0)\sqrt{4000\text{ psi}}}\frac{(1.0)\,(1.0)\,(0.80)}{2.5}\right](0.63\text{ in}) = 14.23\text{ in}$$

Toe Checks [1.2D + 1.6L + 1.6H]

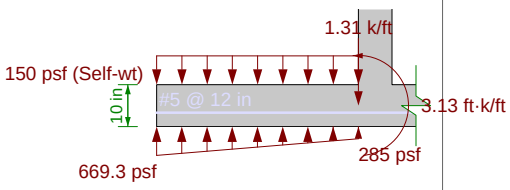
Toe Unfactored Loads

Unfactored Loads



Toe Factored Loads

1.2D + 1.6L + 1.6H



Controlling Moment

Note: Design toe moment is not limited to stem moment because stem base is pinned

M_{toe} = 3.13 ft·k / ft

Flexure Check (ACI 318-08 10.2)

$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$

$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(6.69 \text{ in}) - (0.46 \text{ in}) / 2] = 9.01 \text{ ft·k / ft}$

ϕM_n = 9.01 ft·k / ft ≥ M_u = 3.13 ft·k / ft ✓

Shear Check (ACI 318-08 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2 (1.0) \sqrt{4000 \text{ psi}} (6.69 \text{ in}) = 10.15 \text{ k / ft}$

$\phi V_n = \phi V_c = (0.750)(10.15 \text{ k / ft}) = 7.61 \text{ k / ft}$

ϕV_n = 7.61 k / ft ≥ V_u = 1.22 k / ft ✓

Minimum Strain Check (ACI 318-08 10.3.5)

β_1 = 0.850 ($F'_c \le 4000$ psi)

$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$

$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(6.69 \text{ in})}{(0.46 \text{ in}) / (0.850)} - 1 \right] = 0.0344$

ε_t = 0.0344 ≥ 0.004 ✓

Minimum Steel Check (ACI 318-08 10.5.1)

ϕM_n = 9.01 ft·k / ft ≥ (4 / 3) M_u = [4 / 3](3.13 ft·k / ft) = 4.17 ft·k / ft

Check is waived per ACI 10.5.3 ✓

Shrinkage and Temperature Steel (ACI 318-08 7.12.2)

$\rho_{ST\_prov} = \frac{A_{ST}}{t\, s_{ST}} = \frac{(0.31 \text{ in}^2 / \text{in})}{(10 \text{ in})(12 \text{ in})} = 0.0026$

$\rho_{ST\_min} = \frac{0.0018 (60000)}{f_y} = \frac{0.0018 (60000)}{(60000 \text{ psi})} = 0.0018$

ρ_{ST_min} = 0.0018

ρ_{ST_prov} = 0.0026 ≥ ρ_{ST_min} = 0.0018 ✓

18 inch limit governs

s_{ST_max} = 18 in

s_{ST} = 12 in ≤ s_{ST_max} = 18 in ✓

Development Check (ACI 318-08 12.12, 12.2.3)

$\frac{M_u}{\phi M_n} = \frac{(3.13 \text{ ft·k / ft})}{(9.01 \text{ ft·k / ft})} = 0.3473$ (ratio to represent excess reinforcement)

ψ_t = 1.0 (12 inches or less cast below - 3.00 inches)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (12 in) / 2 = 6 in

cover + d_b / 2 = (3 in) + (0.63 in) / 2 = 3.31 in

c_b = 3.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

$\frac{c_b + K_{tr}}{d_b} = \frac{(3.31 \text{ in}) + (0.0)}{(0.63 \text{ in})} = 5.30$

$l_d = \left(\frac{3.}{40} \frac{f_y}{\lambda \sqrt{F'_c}} \frac{\psi_t \psi_e \psi_s}{2.5} \right) d_b = \left[\frac{3.}{40} \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} \frac{(1.0)(1.0)(0.80)}{2.5} \right] (0.63 \text{ in}) = 14.23 \text{ in}$

Factoring l_d by the excess reinforcement ratio (0.3473) per 12.2.5: l_d = 4.94 in

12 inch minimum controls

l_{d_prov} = 17 in ≥ l_d = 12 in ✓

Heel Checks [1.2D + 1.6L + 1.6H]

Controlling Moment

Note: Design heel moment is not limited to stem moment because stem base is pinned

M_{heel} = 0.54 ft·k / ft

Shear Check (ACI 318-08 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

Unreinforced, use plain concrete provisions: ACI 22.5.4

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$V_n = \frac{4}{3}\lambda\sqrt{F'_c}\,h = \frac{4}{3}(1.0)\sqrt{4000\ psi}\,(8\ in) = 8.1$ k / ft

ϕ = 0.60

$\phi V_n = \phi\, V_n = (0.60)(8.1\ k / ft) = 4.86$ k / ft

ϕV_n = 4.86 k / ft ≥ V_u = 1.07 k / ft ✓

Flexure Check (ACI 318-08 10.2)

Unreinforced, use plain concrete provisions: ACI 22.5.1

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$M_n = 5\sqrt{F'_c}\,S = 5\sqrt{4000\ psi}\,(128\ in^3 / ft) = 3.37$ ft·k / ft (as limited by tension)

$M_n = 0.85\,F'_c\,S = 0.85\,(4000\ psi)\,(128\ in^3 / ft) = 36.27$ ft·k / ft (as limited by compression)

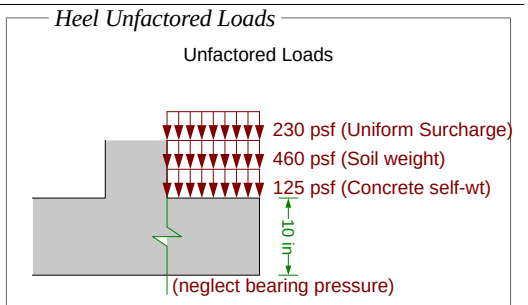
Tension controls

ϕ = 0.60

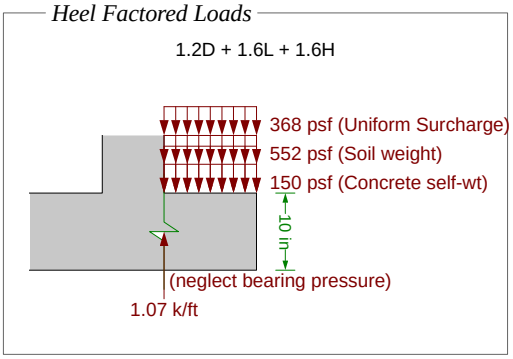
$\phi M_n = \phi\, M_n = (0.60)(3.37\ ft·k / ft) = 2.02$ ft·k / ft

ϕM_n = 2.02 ft·k / ft ≥ M_u = 0.54 ft·k / ft ✓

Heel Unfactored Loads

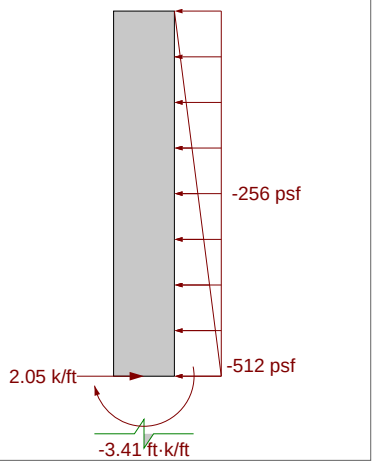


Heel Factored Loads

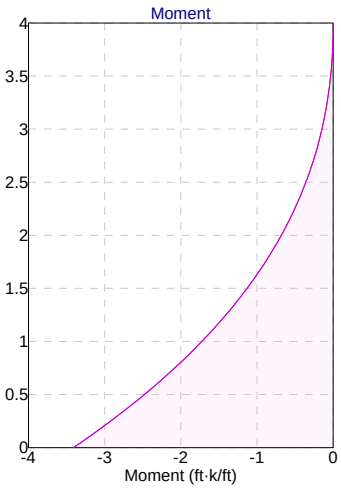


Stem Forces [1.2D + 1.6L + 1.6H]

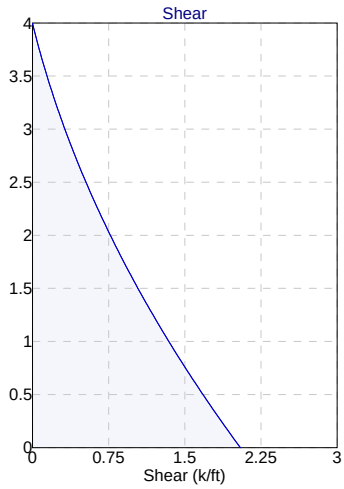
Stem Internal Forces



Stem Internal Forces



Stem Internal Forces

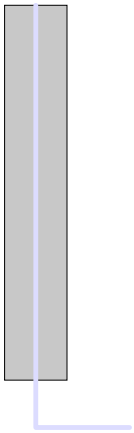


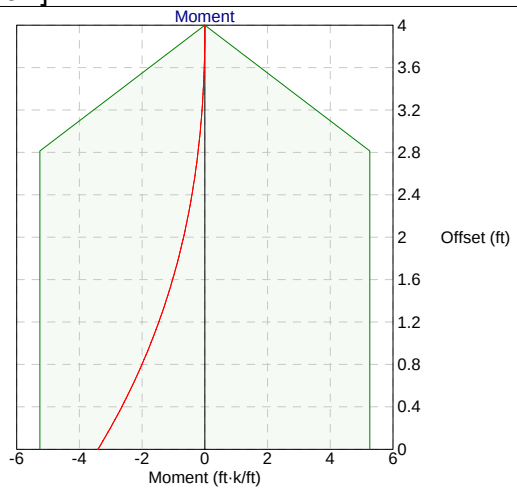
Stem Joint Force Transfer

Location	Force
@ stem base	2.05 k/ft

Stem Internal Forces

Stem Moment Checks [1.2D + 1.6L + 1.6H]





Check (ACI 318-08 Ch 10) @ 0 ft from base

ϕM_n = 5.26 ft·k / ft ≥ M_u = 3.41 ft·k / ft ✓

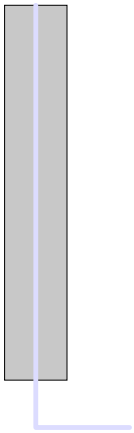
Check (ACI 318-08 Ch 10) @ 2.81 ft from base

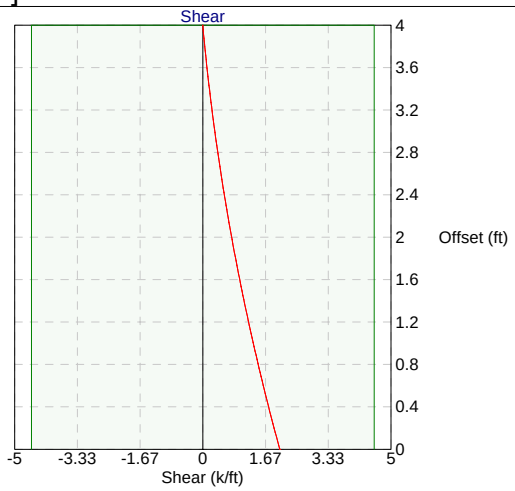
ϕM_n = 5.26 ft·k / ft ≥ M_u = 0.21 ft·k / ft ✓

Check (ACI 318-08 Ch 10) @ 2.83 ft from base

ϕM_n = 5.2 ft·k / ft ≥ M_u = 0.21 ft·k / ft ✓

Stem Shear Checks [1.2D + 1.6L + 1.6H]





Shear Check (ACI 318-08 Ch 11.1.1) @ 0 ft from base

ϕV_n = 4.55 k / ft ≥ V_u = 2.05 k / ft ✓

Stem Miscellaneous Checks [1.2D + 1.6L + 1.6H]

Minimum Steel Check (ACI 318-08 10.5.1) @ 0 ft from base [Stem in negative flexure]

$\phi M_n = 5.26$ ft·k / ft $\geq (4/3) M_u = [4/3](3.41$ ft·k / ft$) = 4.55$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Minimum Steel Check (ACI 318-08 10.5.1) @ 4 ft from base [Stem in negative flexure]

$\phi M_n = 0$ ft·k / ft $\geq (4/3) M_u = [4/3](0$ ft·k / ft$) = 0$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Maximum Steel Check (ACI 318-08 10.3.5) @ 0 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ ($F'_c \leq 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(4 \text{ in})}{(0.46 \text{ in}) / (0.850)} - 1 \right] = 0.0194$$

$\varepsilon_t = 0.0194 \geq 0.004$ ✓

Maximum Steel Check (ACI 318-08 10.3.5) @ 4 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ ($F'_c \leq 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(4 \text{ in})}{(0.46 \text{ in}) / (0.850)} - 1 \right] = 0.0194$$

$\varepsilon_t = 0.0194 \geq 0.004$ ✓

Wall Horizontal Steel (ACI 318-08 14.3.3, 14.3.5)

$$\rho_h = \frac{A_{s\_horz} / s_{horz}}{t} = \frac{(0.31 \text{ in}^2) / (12 \text{ in})}{(8 \text{ in})} = 0.0032$$

$\rho_{h\_min} = 0.0020$ (bars No. 5 or less, not less than 60 ksi)

$\rho_h = 0.0032 \geq \rho_{h\_min} = 0.0020$ ✓

$3 t_{wall} = 3 (8 \text{ in}) = 24$ in

18 inch limit governs

$s_{max} = 18$ in

$s_{horz} = 12$ in $\leq s_{horz\_max} = 18$ in ✓

Development Check (ACI 318-08 12.12, 12.2.3)

$$\frac{M_u}{\phi M_n} = \frac{(3.41 \text{ ft·k / ft})}{(5.26 \text{ ft·k / ft})} = 0.6487$$ (ratio to represent excess reinforcement)

$\psi_e = 1.0$ (uncoated hooked bars)

$\lambda = 1.0$ (normal weight concrete)

$$l_{dh} = 0.02 \psi_e \frac{f_y}{\lambda \sqrt{F'_c}} d_b = 0.02 (1.0) \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} (0.63 \text{ in}) = 11.86 \text{ in}$$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): $l_{dh} = 8.3$ in

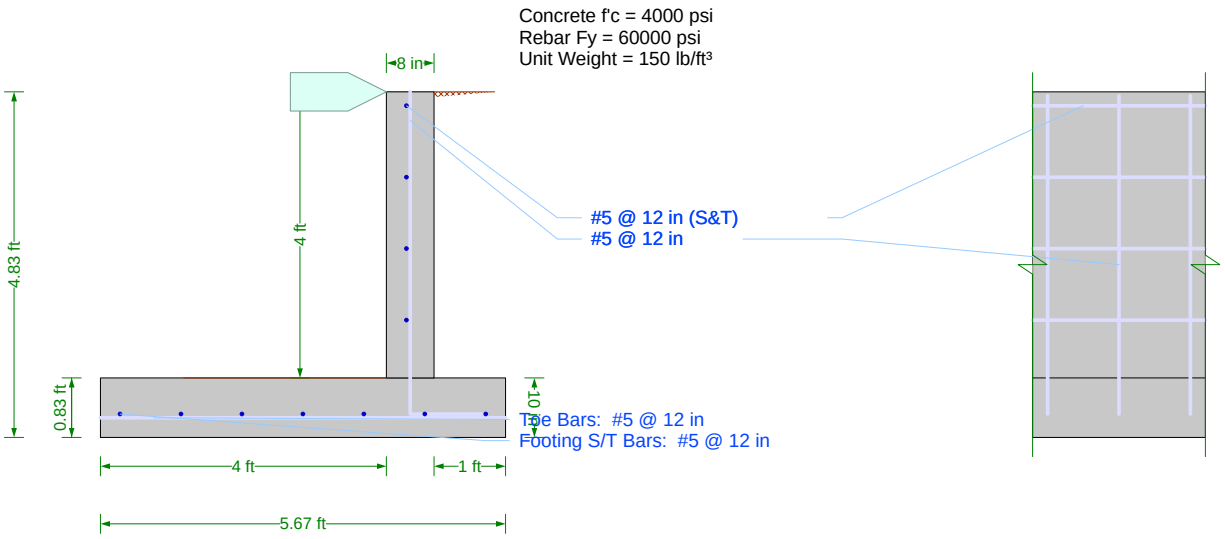
Factoring l_{dh} by the excess reinforcement ratio (0.6487) per 12.5.3 (d): $l_{dh} = 5.38$ in

$8 d_b = 8 (0.63 \text{ in}) = 5.0$ (minimum limit, does not control)

6 inch minimum controls

$l_{dh\_prov} = 7$ in $\geq l_{dh} = 6$ in ✓

Design Detail



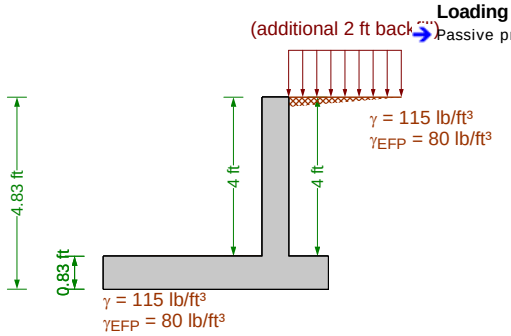
Check Summary

Ratio	Check	Provided	Required	Combination
----- Stability Checks -----				
✓ 0.205	Bearing Pressure	3000 psf	614 psf	1.0D + 1.0L + 1.0H
✓ 0.935	Bearing Eccentricity	10.59 in	11.33 in	1.0D + 1.0L + 1.0H
----- Toe Checks -----				
✓ 0.045	Shear	7.61 k/ft	0.35 k/ft	1.2D + 1.6L + 1.6H
✓ 0.045	Moment	9.01 ft·k/ft	0.4 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.116	Min Strain	0.0344	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0.03 in²	0 in²	1.2D + 1.6L + 1.6H
✓ 0.706	Development	17 in	12 in	1.2D + 1.6L + 1.6H
✓ 0.667	S&T Max Spacing	12 in	18 in	1.2D + 1.6L + 1.6H
✓ 0.697	S&T Min Rho	0.0026	0.0018	1.2D + 1.6L + 1.6H
----- Heel Checks -----				
✓ 0.220	Shear	4.86 k/ft	1.07 k/ft	1.2D + 1.6L + 1.6H
✓ 0.264	Moment	2.02 ft·k/ft	0.54 ft·k/ft	1.2D + 1.6L + 1.6H
----- Stem Checks -----				
✓ 0.196	Moment	5.26 ft·k/ft	1.03 ft·k/ft	1.2D + 1.6L + 1.6H
✓ 0.262	Shear	4.55 k/ft	1.19 k/ft	1.2D + 1.6L + 1.6H
✓ 0.206	Max Steel	0.0194	0.0040	1.2D + 1.6L + 1.6H
✓ 0.000	Min Steel	0 in²/in	0 in²/in	1.2D + 1.6L + 1.6H
✓ 0.857	Base Development	7 in	6 in	1.2D + 1.6L + 1.6H
✓ 0.619	Horz Bar Rho	0.0032	0.0020	1.2D + 1.6L + 1.6H
✓ 0.667	Horz Bar Spacing	12 in	18 in	1.2D + 1.6L + 1.6H

Criteria

Building Code	IBC 2009
Concrete Load Combs	IBC 2009 (Strength)
Masonry Load Combs	ASCE 7-10 (ASD)
Stability Load Combs	ASCE 7-10 (ASD)
Restrained Against Sliding	Yes
Neglect Bearing At Heel	Yes
Use Vert. Comp. for OT	No
Use Vert. Comp. for Sliding	No
Use Vert. Comp. for Bearing	Yes
Use Surcharge for Sliding & OT	Yes
Use Surcharge for Bearing	Yes
Neglect Soil Over Toe	No
Neglect Backfill Wt. for Coulomb	No
Factor Soil Weight As Dead	Yes
Use Passive Force for OT	Yes
Assume Pressure To Top	Yes
Extend Backfill Pressure To Key Bottom	No
Use Toe Passive Pressure for Bearing	No
Required F.S. for OT	1.70
Required F.S. for Sliding	1.70
Has Different Safety Factors for Seismic	No
Allowable Bearing Pressure	3000 psf
Req'd Bearing Location	Middle third
Wall Friction Angle	25°
Friction Coefficent	0.35
Soil Reaction Modulus	172800 lb/ft³

Loads

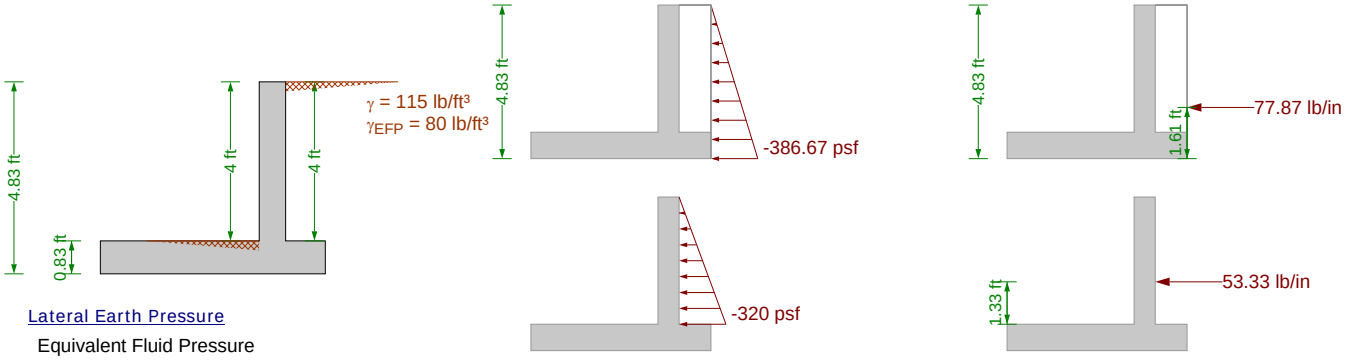


Load Combinations

IBC 2009 (Strength)

1.2D + 1.6L + 1.6H
1.2D + 0.5L
0.9D + 1.6H
1.4D
1.2D

Backfill Pressure



Lateral Earth Pressure

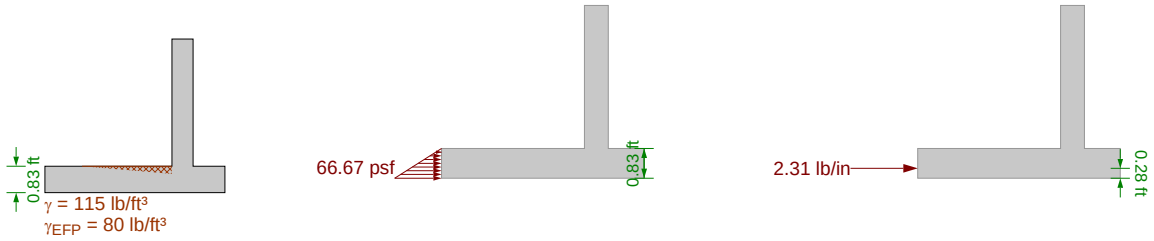
Equivalent Fluid Pressure

$\sigma_h = H\,\gamma_{fluid}$ = (4.83 ft)(80 lb / ft³) = 386.7 psf

Lateral Earth Pressure (stem only)

$\sigma_h = H\,\gamma_{fluid}$ = (4 ft)(80 lb / ft³) = 320 psf

Passive Pressure

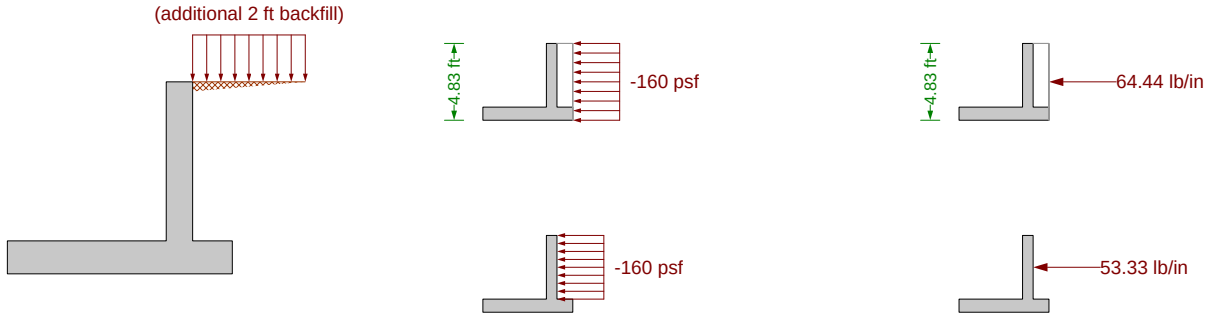


Lateral Earth Pressure

Equivalent Fluid Pressure

$\sigma_h = H\,\gamma_{fluid} = (0.83\text{ ft})(80\text{ lb / ft}^3) = 66.67\text{ psf}$

Uniform Surcharge Pressure



Lateral Surcharge Pressure

$q = \gamma\,H_{sur} = (115\text{ lb / ft}^3)(2\text{ ft}) = 230\text{ psf}$

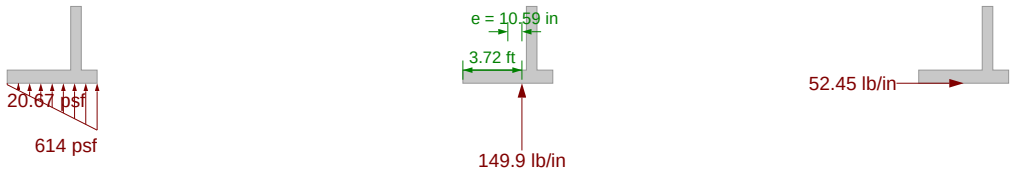
Equivalent Fluid Pressure

$K = \frac{\gamma_{fluid}}{\gamma} = \frac{(80\text{ lb / ft}^3)}{(115\text{ lb / ft}^3)} = 0.6957$

$\sigma_{sur} = K\,q = (0.6957)(230\text{ psf}) = 160\text{ psf}$

Wall/Soil Weights

Bearing Pressure



Friction

$F = \mu R = (0.350)(149.9 \text{ lb / in}) = 52.45 \text{ lb / in}$

Bearing Pressure Calculation

Contributing Forces

	Vert Force	...offset	Horz Force	...offset	OT Moment
Backfill Pressure	-0 lb/in	-	0 lb/in	-	-0 in·lb/ft
Uniform Surcharge Pressure	-19.17 lb/in	5.17 ft	0 lb/in	-	-14260 in·lb/ft
Footing Weight	-59.03 lb/in	2.83 ft	0 lb/in	-	-24083.33 in·lb/ft
Stem Weight	-33.33 lb/in	4.33 ft	0 lb/in	-	-20800 in·lb/ft
Backfill Weight	-38.33 lb/in	5.17 ft	0 lb/in	-	-28520 in·lb/ft
Soil over toe Weight	-0 lb/in	-	0 lb/in	-	-0 in·lb/ft
Stem Base Shear	-0 lb/in	-	-62.22 lb/in	0.83 ft	7467 in·lb/ft
Stem Base Moment	0 lb/in	-	0 lb/in	-	0 in·lb/ft
	-149.86 lb/in				-80196.67 in·lb/ft

$$\frac{-80196.67 \text{ in·lb / ft}}{-149.86 \text{ lb / in}} = 3.72 \text{ ft}$$

Stability Checks [1.0D + 1.0L + 1.0H]

Overturning Check

Check not performed; wall has lateral support.

Sliding Check

Check not performed; restrained against sliding.

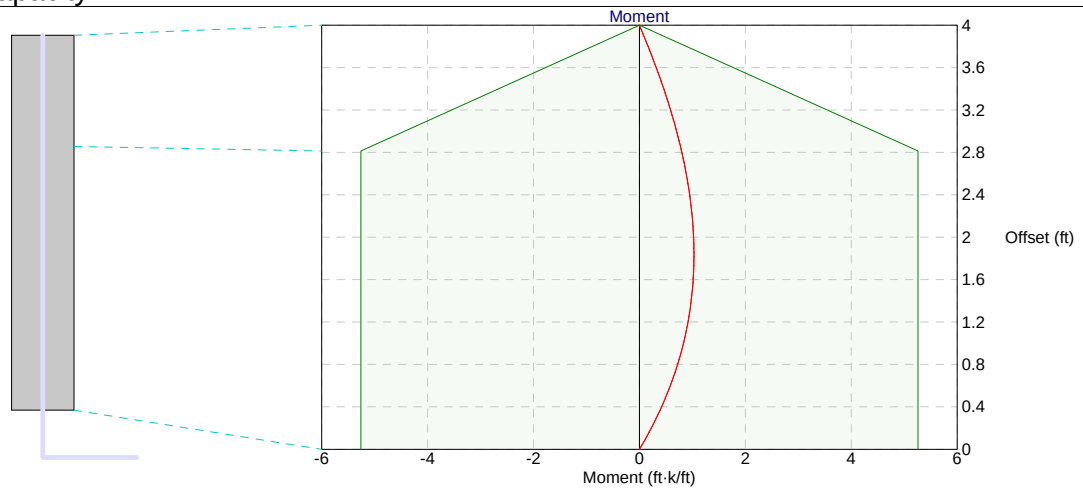
Bearing Capacity Check

Bearing pressure < allowable (614 psf < 3000 psf) - OK
Bearing resultant eccentricity < allowable (10.59 in < 11.33 in) - OK

Wall Top Displacement

Not calculated because this wall has a lateral restraint.

Stem Flexural Capacity



Capacity (ACI 318-08 10.2) @ 0 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 0 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 2.81 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 2.81 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0.46 \text{ in}) / 2] = 5.26 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 4 ft from base [Negative bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

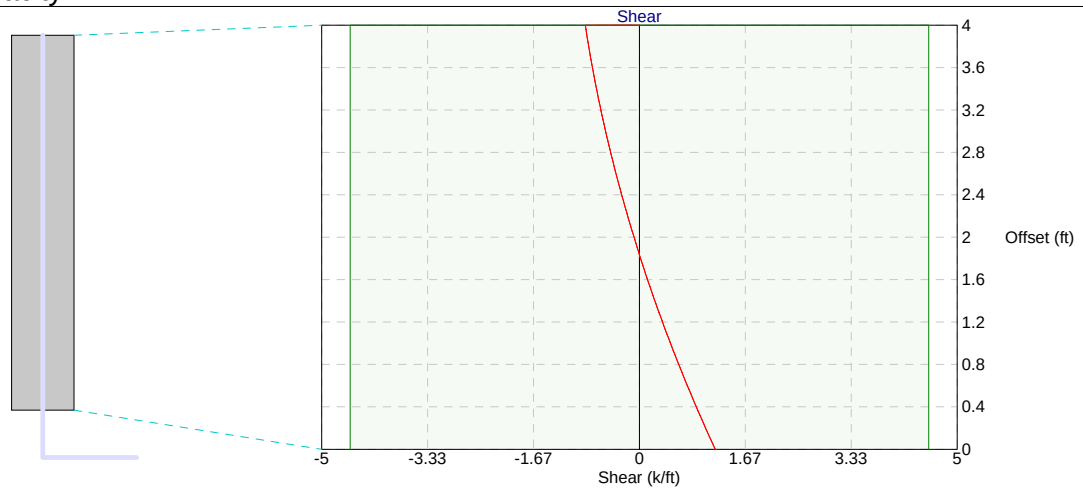
$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Capacity (ACI 318-08 10.2) @ 4 ft from base [Positive bending]

$$a = \frac{A_s f_y}{0.85 f'_c} = \frac{(0 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0 \text{ in}^2 / \text{in})(60000 \text{ psi})[(4 \text{ in}) - (0 \text{ in}) / 2] = 0 \text{ ft·k / ft}$$

Stem Shear Capacity



Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 0 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)\,(6.07\ k/ft) = 4.55\ k/ft$

Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 0 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)\,(6.07\ k/ft) = 4.55\ k/ft$

Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 4 ft from base [Positive shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)\,(6.07\ k/ft) = 4.55\ k/ft$

Shear Capacity (ACI 318-08 11.1.1, 11.2.1) @ 4 ft from base [Negative shear]

λ = 1.0 (normal weight concrete)

$V_c = 2 \lambda \sqrt{F'_c}\, d = 2\,(1.0)\,\sqrt{4000\ psi}\,(4\ in) = 6.07\ k/ft$

$\phi V_n = \phi V_c = (0.750)\,(6.07\ k/ft) = 4.55\ k/ft$

Stem Development/Lap Length Calculations

Main vertical stem bars (bottom end) - Development Length Calculation (ACI 318-08 12.2.3, 12.5)

ψ_e = 1.0 (uncoated hooked bars)

λ = 1.0 (normal weight concrete)

$$l_{dh} = 0.02\,\psi_e \frac{f_y}{\lambda\sqrt{F'_c}}\,d_b = 0.02\,(1.0)\frac{(60000\text{ psi})}{(1.0)\sqrt{4000\text{ psi}}}(0.63\text{ in}) = 11.86\text{ in}$$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): l_{dh} = 8.3 in

8 d_b = 8 (0.63 in) = 5.0 (minimum limit, does not control)

Main vertical stem bars (top end) - Development Length Calculation (ACI 318-08 12.2.3, 12.5)

ψ_t = 1.0 (bars are not horizontal)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (12 in) / 2 = 6 in

cover + d_b / 2 = (2 in) + (0.63 in) / 2 = 2.31 in

c_b = 2.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

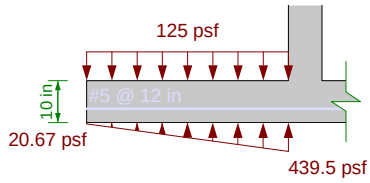
$$\frac{c_b + K_{tr}}{d_b} = \frac{(2.31\text{ in}) + (0.0)}{(0.63\text{ in})} = 3.70$$

$$l_d = \left(\frac{3.}{40}\frac{f_y}{\lambda\sqrt{F'_c}}\frac{\psi_t\,\psi_e\,\psi_s}{2.5}\right)d_b = \left[\frac{3.}{40}\frac{(60000\text{ psi})}{(1.0)\sqrt{4000\text{ psi}}}\frac{(1.0)\,(1.0)\,(0.80)}{2.5}\right](0.63\text{ in}) = 14.23\text{ in}$$

Toe Checks [1.2D + 1.6L + 1.6H]

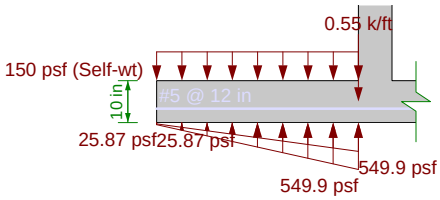
Toe Unfactored Loads

Unfactored Loads



Toe Factored Loads

1.2D + 1.6L + 1.6H



Controlling Moment

Note: Design toe moment is not limited to stem moment because stem base is pinned

M_{toe} = 0.4 ft·k / ft

Flexure Check (ACI 318-08 10.2)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\phi M_n = \phi A_s f_y (d - a / 2) = (0.90)(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})[(6.69 \text{ in}) - (0.46 \text{ in}) / 2] = 9.01 \text{ ft·k / ft}$$

ϕM_n = 9.01 ft·k / ft ≥ M_u = 0.4 ft·k / ft ✓

Shear Check (ACI 318-08 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

$$V_c = 2 \lambda \sqrt{F'_c} d = 2 (1.0) \sqrt{4000 \text{ psi}} (6.69 \text{ in}) = 10.15 \text{ k / ft}$$

$\phi V_n = \phi V_c = (0.750)(10.15 \text{ k / ft}) = 7.61 \text{ k / ft}$

ϕV_n = 7.61 k / ft ≥ V_u = 0.35 k / ft ✓

Minimum Strain Check (ACI 318-08 10.3.5)

β_1 = 0.850 ($F'_c \le 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(6.69 \text{ in})}{(0.46 \text{ in}) / (0.850)} - 1 \right] = 0.0344$$

ε_t = 0.0344 ≥ 0.004 ✓

Minimum Steel Check (ACI 318-08 10.5.1)

ϕM_n = 9.01 ft·k / ft ≥ (4 / 3) M_u = [4 / 3](0.4 ft·k / ft) = 0.54 ft·k / ft

Check is waived per ACI 10.5.3 ✓

Shrinkage and Temperature Steel (ACI 318-08 7.12.2)

$$\rho_{ST\_prov} = \frac{A_{ST}}{t \, s_{ST}} = \frac{(0.31 \text{ in}^2 / \text{in})}{(10 \text{ in})(12 \text{ in})} = 0.0026$$

$$\rho_{ST\_min} = \frac{0.0018 (60000)}{f_y} = \frac{0.0018 (60000)}{(60000 \text{ psi})} = 0.0018$$

ρ_{ST_min} = 0.0018

ρ_{ST_prov} = 0.0026 ≥ ρ_{ST_min} = 0.0018 ✓

18 inch limit governs

s_{ST_max} = 18 in

s_{ST} = 12 in ≤ s_{ST_max} = 18 in ✓

Development Check (ACI 318-08 12.12, 12.2.3)

$$\frac{M_u}{\phi M_n} = \frac{(0.4 \text{ ft·k / ft})}{(9.01 \text{ ft·k / ft})} = 0.0449$$ (ratio to represent excess reinforcement)

ψ_t = 1.0 (12 inches or less cast below - 3.00 inches)

ψ_e = 1.0 (bar not epoxy coated)

ψ_s = 0.80 (bars are #6 or smaller)

λ = 1.0 (normal weight concrete)

s / 2 = (12 in) / 2 = 6 in

cover + d_b / 2 = (3 in) + (0.63 in) / 2 = 3.31 in

c_b = 3.31 in (lesser of half spacing, ctr to surface)

K_{tr} = 0.0 (no transverse reinforcement)

$$\frac{c_b + K_{tr}}{d_b} = \frac{(3.31 \text{ in}) + (0.0)}{(0.63 \text{ in})} = 5.30$$

$$l_d = \left(\frac{3.}{40} \frac{f_y}{\lambda \sqrt{F'_c}} \frac{\psi_t \psi_e \psi_s}{2.5} \right) d_b = \left[\frac{3.}{40} \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} \frac{(1.0)(1.0)(0.80)}{2.5} \right] (0.63 \text{ in}) = 14.23 \text{ in}$$

Factoring l_d by the excess reinforcement ratio (0.0449) per 12.2.5: l_d = 0.64 in

12 inch minimum controls

l_{d_prov} = 17 in ≥ l_d = 12 in ✓

Heel Checks [1.2D + 1.6L + 1.6H]

Controlling Moment

Note: Design heel moment is not limited to stem moment because stem base is pinned

M_{heel} = 0.54 ft·k / ft

Shear Check (ACI 318-08 11.1.1, 11.11.3.1)

λ = 1.0 (normal weight concrete)

Unreinforced, use plain concrete provisions: ACI 22.5.4

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$V_n = \frac{4}{3}\lambda\sqrt{F'_c}\,h = \frac{4}{3}(1.0)\sqrt{4000\ psi}\,(8\ in) = 8.1$ k / ft

ϕ = 0.60

$\phi V_n = \phi\, V_n = (0.60)(8.1\ k / ft) = 4.86$ k / ft

ϕV_n = 4.86 k / ft ≥ V_u = 1.07 k / ft ✓

Flexure Check (ACI 318-08 10.2)

Unreinforced, use plain concrete provisions: ACI 22.5.1

Note: Effective thickness reduced by 2 inches for concrete cast on soil (ACI 22.4.8)

$M_n = 5\sqrt{F'_c}\,S = 5\sqrt{4000\ psi}\,(128\ in^3 / ft) = 3.37$ ft·k / ft (as limited by tension)

$M_n = 0.85\,F'_c\,S = 0.85\,(4000\ psi)\,(128\ in^3 / ft) = 36.27$ ft·k / ft (as limited by compression)

Tension controls

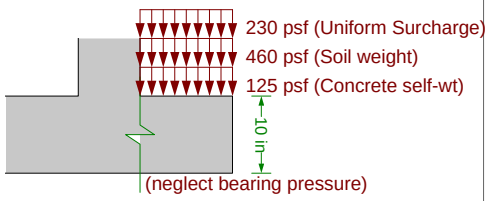
ϕ = 0.60

$\phi M_n = \phi\, M_n = (0.60)(3.37\ ft·k / ft) = 2.02$ ft·k / ft

ϕM_n = 2.02 ft·k / ft ≥ M_u = 0.54 ft·k / ft ✓

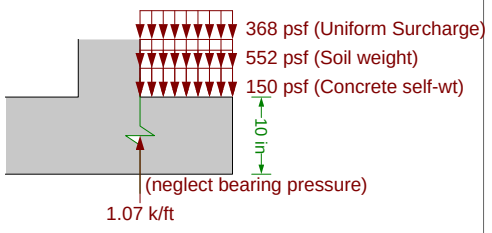
Heel Unfactored Loads

Unfactored Loads



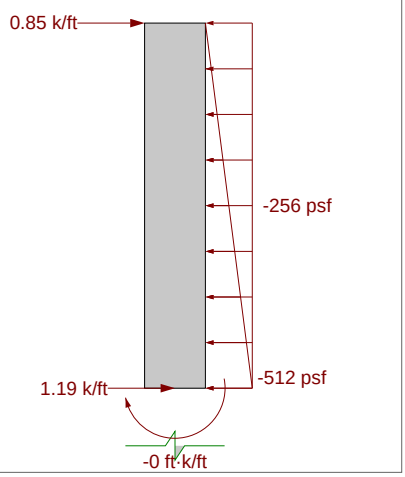
Heel Factored Loads

1.2D + 1.6L + 1.6H

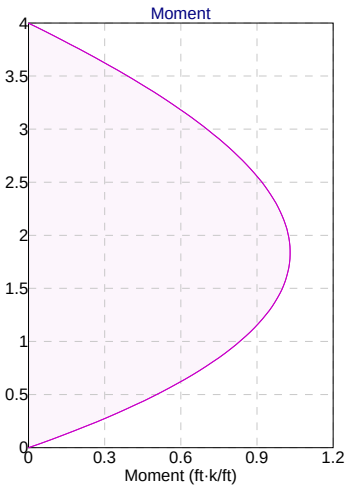


Stem Forces [1.2D + 1.6L + 1.6H]

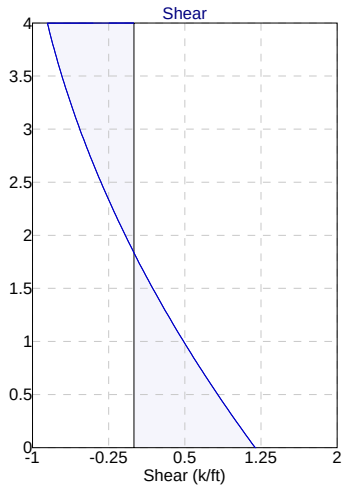
Stem Internal Forces



Stem Internal Forces



Stem Internal Forces

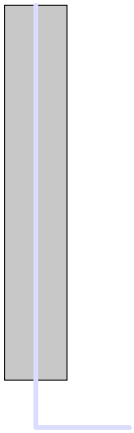


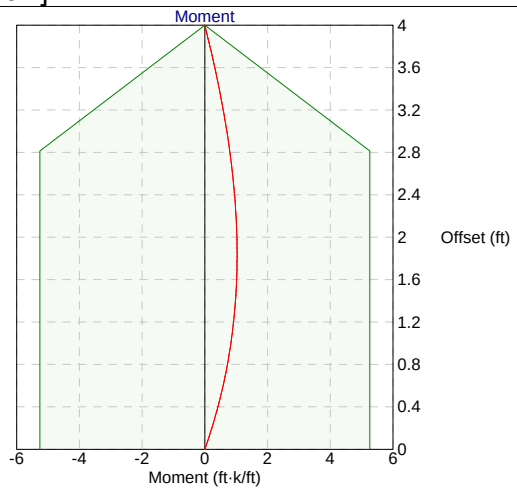
Stem Joint Force Transfer

Location	Force
@ stem base	1.19 k/ft

Stem Internal Forces

Stem Moment Checks [1.2D + 1.6L + 1.6H]





Check (ACI 318-08 Ch 10) @ 1.82 ft from base [Positive bending]

ϕM_n = 5.26 ft·k / ft ≥ M_u = 1.03 ft·k / ft ✓

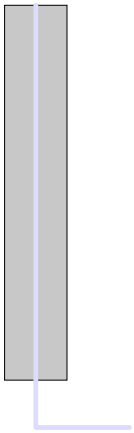
Check (ACI 318-08 Ch 10) @ 2.81 ft from base [Positive bending]

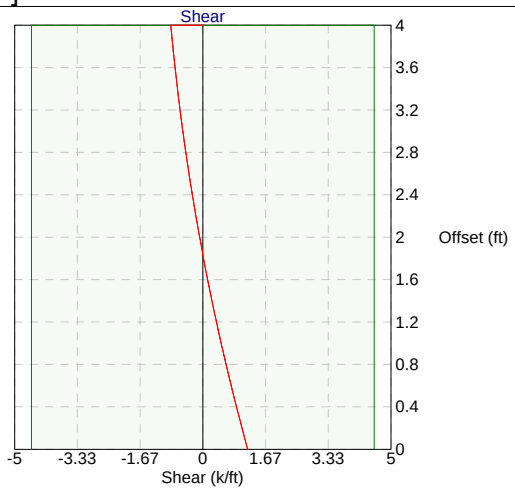
ϕM_n = 5.26 ft·k / ft ≥ M_u = 0.79 ft·k / ft ✓

Check (ACI 318-08 Ch 10) @ 2.83 ft from base [Positive bending]

ϕM_n = 5.2 ft·k / ft ≥ M_u = 0.79 ft·k / ft ✓

Stem Shear Checks [1.2D + 1.6L + 1.6H]





Shear Check (ACI 318-08 Ch 11.1.1) @ 0 ft from base [Positive shear]

ϕV_n = 4.55 k / ft ≥ V_u = 1.19 k / ft ✓

Shear Check (ACI 318-08 Ch 11.1.1) @ 4 ft from base [Negative shear]

ϕV_n = 4.55 k / ft ≥ V_u = 0.85 k / ft ✓

Stem Miscellaneous Checks [1.2D + 1.6L + 1.6H]

Minimum Steel Check (ACI 318-08 10.5.1) @ 0 ft from base [Stem in negative flexure]

$\phi M_n = 5.26$ ft·k / ft $\geq (4 / 3) M_u = [4 / 3] (0$ ft·k / ft$) = 0$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Minimum Steel Check (ACI 318-08 10.5.1) @ 4 ft from base [Stem in negative flexure]

$\phi M_n = 0$ ft·k / ft $\geq (4 / 3) M_u = [4 / 3] (0$ ft·k / ft$) = 0$ ft·k / ft

Check is waived per ACI 10.5.3 ✓

Maximum Steel Check (ACI 318-08 10.3.5) @ 0 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ ($F'_c \leq 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(4 \text{ in})}{(0.46 \text{ in}) / (0.850)} - 1 \right] = 0.0194$$

$\varepsilon_t = 0.0194 \geq 0.004$ ✓

Maximum Steel Check (ACI 318-08 10.3.5) @ 4 ft from base [Stem in negative flexure]

$\beta_1 = 0.850$ ($F'_c \leq 4000$ psi)

$$a = \frac{A_s f_y}{0.85 F'_c} = \frac{(0.03 \text{ in}^2 / \text{in})(60000 \text{ psi})}{0.85 (4000 \text{ psi})} = 0.46 \text{ in}$$

$$\varepsilon_t = 0.003 \left(\frac{d}{a / \beta_1} - 1 \right) = 0.003 \left[\frac{(4 \text{ in})}{(0.46 \text{ in}) / (0.850)} - 1 \right] = 0.0194$$

$\varepsilon_t = 0.0194 \geq 0.004$ ✓

Wall Horizontal Steel (ACI 318-08 14.3.3, 14.3.5)

$$\rho_h = \frac{A_{s\_horz} / s_{horz}}{t} = \frac{(0.31 \text{ in}^2) / (12 \text{ in})}{(8 \text{ in})} = 0.0032$$

$\rho_{h\_min} = 0.0020$ (bars No. 5 or less, not less than 60 ksi)

$\rho_h = 0.0032 \geq \rho_{h\_min} = 0.0020$ ✓

$3 t_{wall} = 3 (8 \text{ in}) = 24$ in

18 inch limit governs

$s_{max} = 18$ in

$s_{horz} = 12$ in $\leq s_{horz\_max} = 18$ in ✓

Development Check (ACI 318-08 12.12, 12.2.3)

$\frac{M_u}{\phi M_n} = \frac{(0 \text{ ft·k / ft})}{(5.26 \text{ ft·k / ft})} = 0.0$ (ratio to represent excess reinforcement)

$\psi_e = 1.0$ (uncoated hooked bars)

$\lambda = 1.0$ (normal weight concrete)

$$l_{dh} = 0.02 \psi_e \frac{f_y}{\lambda \sqrt{F'_c}} d_b = 0.02 (1.0) \frac{(60000 \text{ psi})}{(1.0) \sqrt{4000 \text{ psi}}} (0.63 \text{ in}) = 11.86 \text{ in}$$

Factoring l_{dh} by the 0.7 multiplier of 12.5.3 (a): $l_{dh} = 8.3$ in

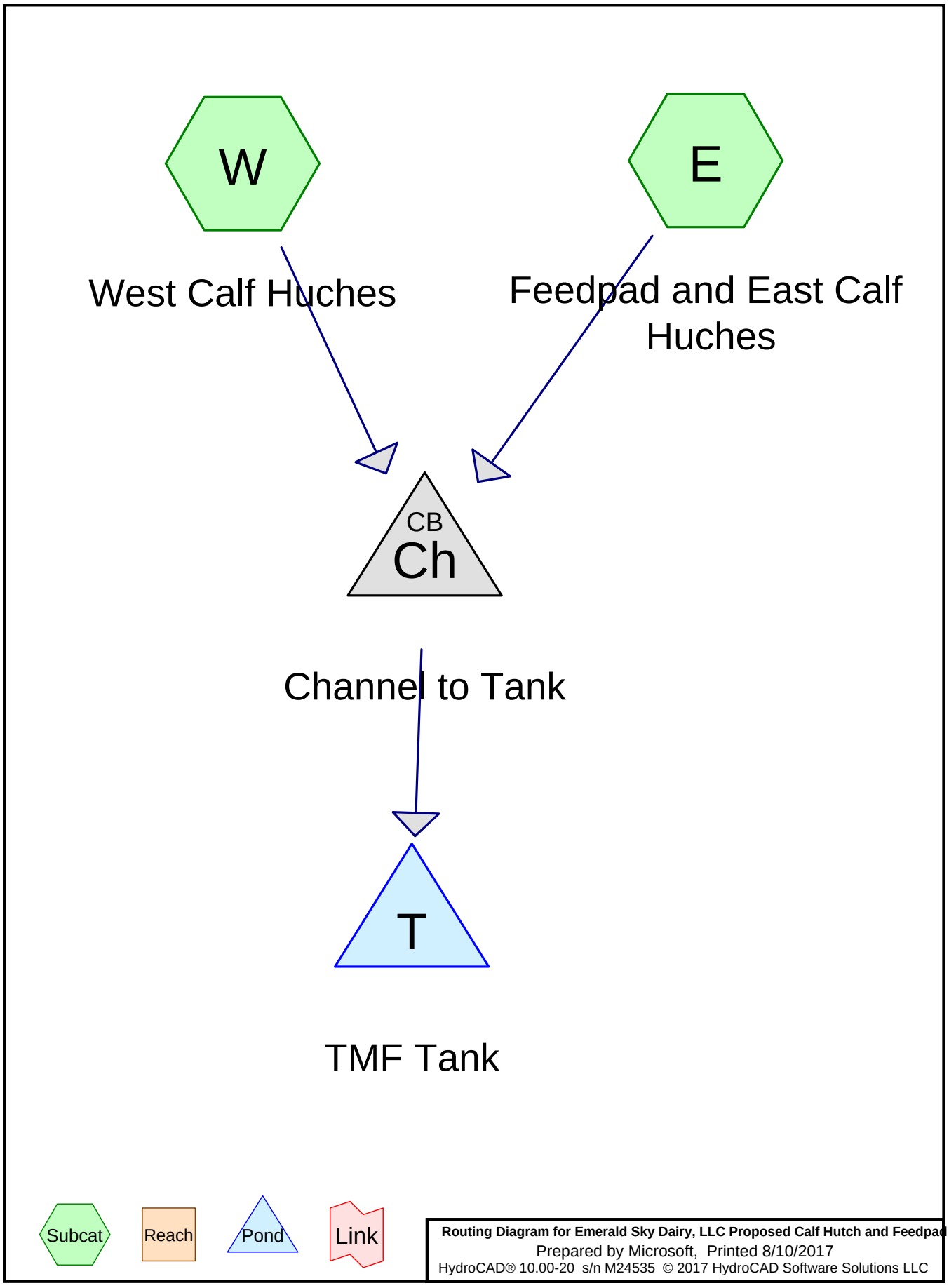
Factoring l_{dh} by the excess reinforcement ratio (0.0000) per 12.5.3 (d): $l_{dh} = 0$ in

$8 d_b = 8 (0.63 \text{ in}) = 5.0$ (minimum limit, does not control)

6 inch minimum controls

$l_{dh\_prov} = 7$ in $\geq l_{dh} = 6$ in ✓

ATTACHMENT 3
HYDROLOGY



Routing Diagram for Emerald Sky Dairy, LLC Proposed Calf Hutch and Feedpad
Prepared by Microsoft, Printed 8/10/2017
HydroCAD® 10.00-20 s/n M24535 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.744	98	East Calf Hutch Slab (E)
2.043	98	Feedpad Slab (E)
0.545	98	West Calf Hutch Slab (W)
3.332	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
3.332	Other	E, W
3.332		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	0.744	0.744	East Calf Hutch Slab	E
0.000	0.000	0.000	0.000	2.043	2.043	Feedpad Slab	E
0.000	0.000	0.000	0.000	0.545	0.545	West Calf Hutch Slab	W
0.000	**0.000**	**0.000**	**0.000**	**3.332**	**3.332**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	Ch	1,190.74	1,190.37	36.3	0.0102	0.013	144.0	24.0	0.0

Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E: Feedpad and East Calf Runoff Area=121,408 sf 100.00% Impervious Runoff Depth=4.86"
Flow Length=673' Tc=7.4 min CN=98 Runoff=19.06 cfs 1.129 af

Subcatchment W: West Calf Huches Runoff Area=23,746 sf 100.00% Impervious Runoff Depth=4.86"
Flow Length=259' Slope=0.0065 '/' Tc=4.3 min CN=98 Runoff=4.10 cfs 0.221 af

Pond Ch: Channel to Tank Peak Elev=1,191.83' Inflow=22.54 cfs 1.350 af
144.0" x 24.0" Box Culvert n=0.013 L=36.3' S=0.0102 '/' Outflow=22.54 cfs 1.350 af

Pond T: TMF Tank Peak Elev=1,191.82' Storage=18,048 cf Inflow=22.54 cfs 1.350 af
Outflow=4.03 cfs 1.334 af

Total Runoff Area = 3.332 ac Runoff Volume = 1.350 af Average Runoff Depth = 4.86"
0.00% Pervious = 0.000 ac 100.00% Impervious = 3.332 ac

Summary for Subcatchment E: Feedpad and East Calf Huches

Subcatchment is comprised of Feedpad Area and Eastern Calf Hutch Area

Tc flow length divided into two flow types- sheet flow for first 300 ft and shallow concentrated flow for remaining distance within defined area

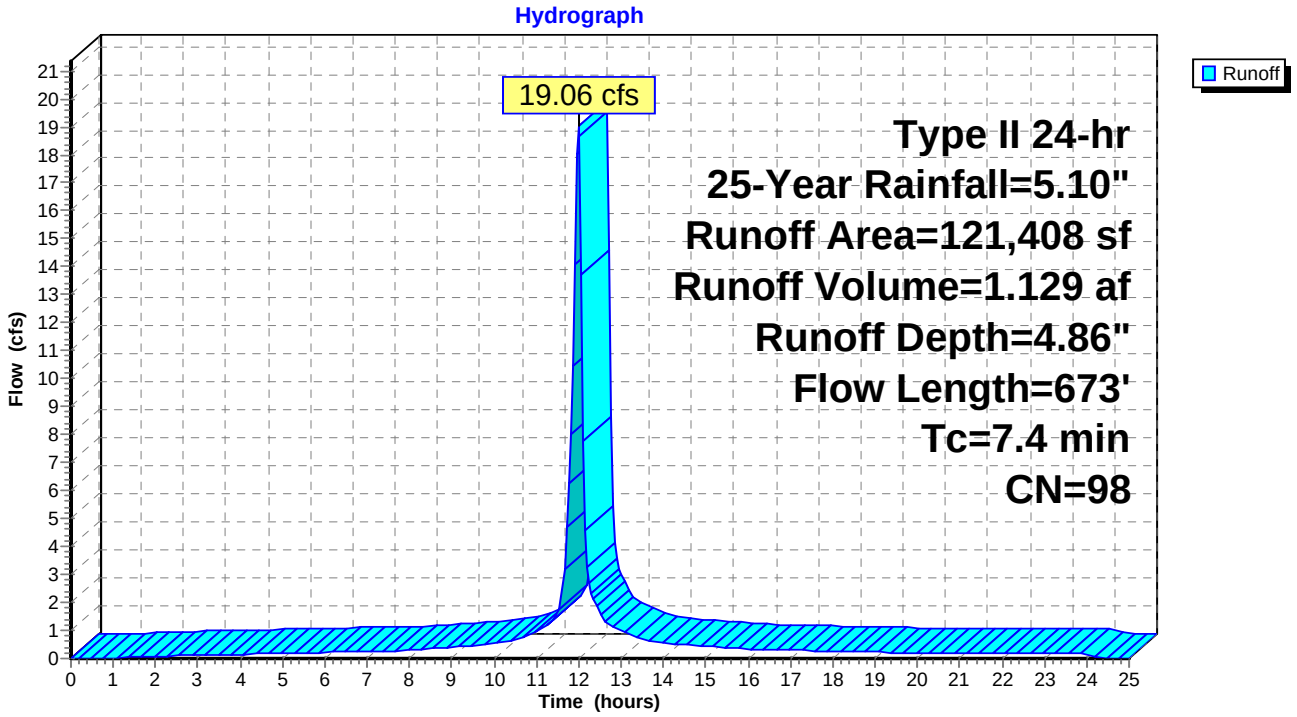
Runoff = 19.06 cfs @ 11.98 hrs, Volume= 1.129 af, Depth= 4.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=5.10"

	Area (sf)	CN	Description
*	88,984	98	Feedpad Slab
*	32,424	98	East Calf Hutch Slab
	121,408	98	Weighted Average
	121,408		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	300	0.0130	1.35		**Sheet Flow, Flow from NE corner of feedpad to NE corner of eas** Smooth surfaces n= 0.011 P2= 2.82"
0.2	33	0.0130	2.31		**Shallow Concentrated Flow, Flow from feedpad to NE corner of** Paved Kv= 20.3 fps
3.5	340	0.0062	1.60		**Shallow Concentrated Flow, Flow distance from NE corner of ca** Paved Kv= 20.3 fps
7.4	673	Total			

Subcatchment E: Feedpad and East Calf Huches



Summary for Subcatchment W: West Calf Huches

Sheet flow used for entire Tc flow length.

[49] Hint: Tc<2dt may require smaller dt

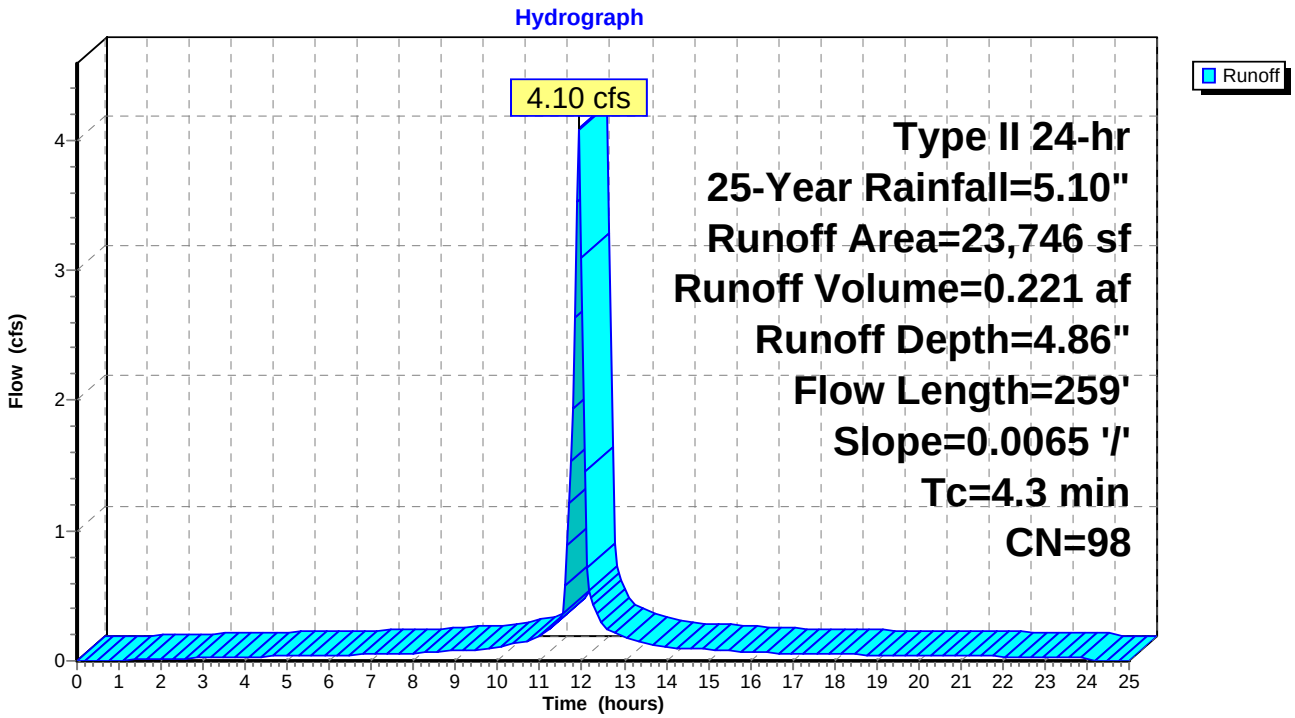
Runoff = 4.10 cfs @ 11.94 hrs, Volume= 0.221 af, Depth= 4.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=5.10"

	Area (sf)	CN	Description
*	23,746	98	West Calf Hutch Slab
	23,746		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	259	0.0065	1.00		**Sheet Flow, Flow from NW corner of calf hutch slab to channel** Smooth surfaces n= 0.011 P2= 2.82"

Subcatchment W: West Calf Huches



Summary for Pond Ch: Channel to Tank

[57] Hint: Peaked at 1,191.83' (Flood elevation advised)

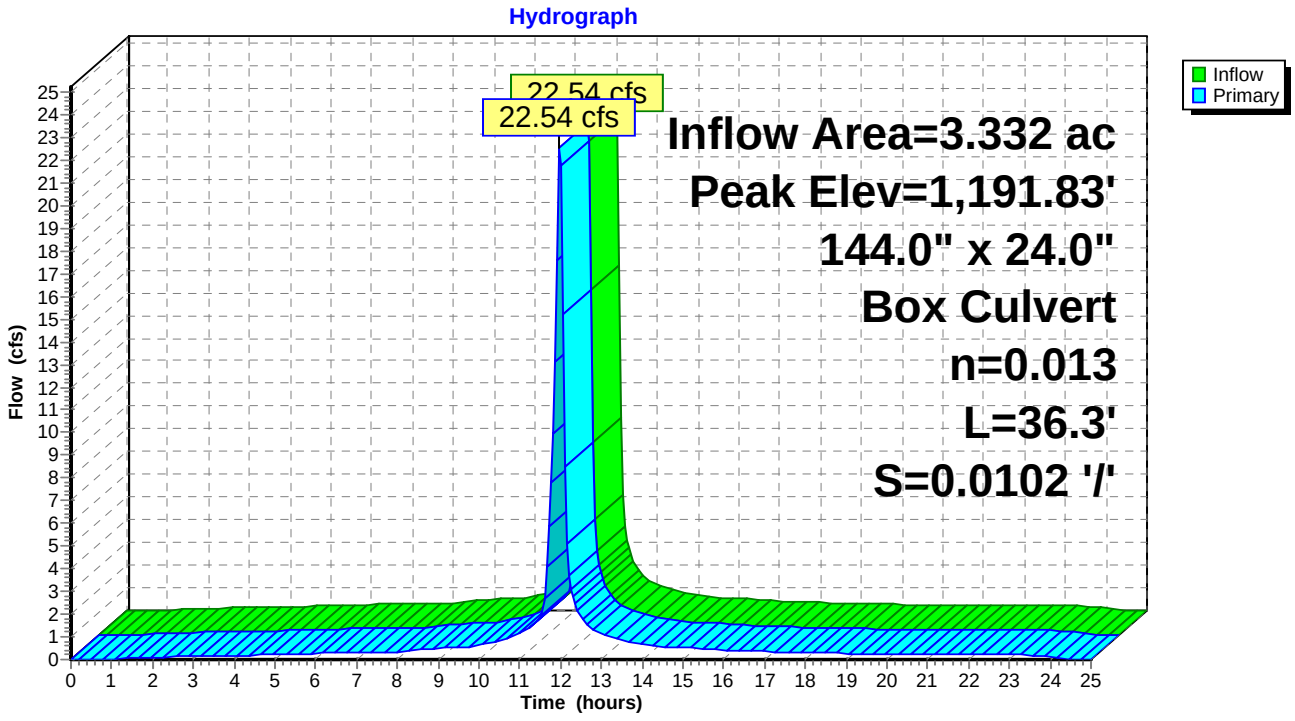
Inflow Area = 3.332 ac,100.00% Impervious, Inflow Depth = 4.86" for 25-Year event
Inflow = 22.54 cfs @ 11.97 hrs, Volume= 1.350 af
Outflow = 22.54 cfs @ 11.97 hrs, Volume= 1.350 af, Atten= 0%, Lag= 0.0 min
Primary = 22.54 cfs @ 11.97 hrs, Volume= 1.350 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 1,191.83' @ 12.24 hrs

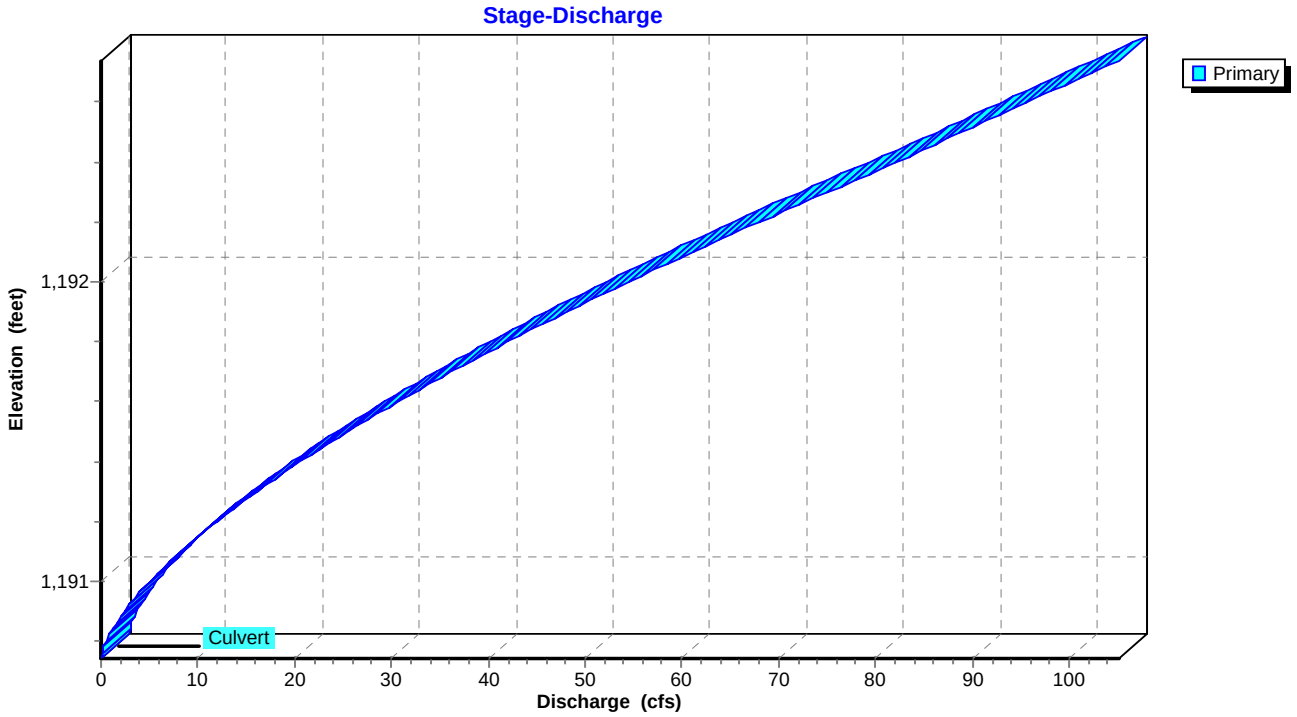
Device	Routing	Invert	Outlet Devices
#1	Primary	1,190.74'	**144.0" W x 24.0" H Box Culvert** L= 36.3' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 1,190.74' / 1,190.37' S= 0.0102 '/' Cc= 0.900 n= 0.013 Concrete, trowel finish, Flow Area= 24.00 sf

Primary OutFlow Max=11.49 cfs @ 11.97 hrs HW=1,191.62' TW=1,191.56' (Dynamic Tailwater)
1=Culvert (Outlet Controls 11.49 cfs @ 1.46 fps)

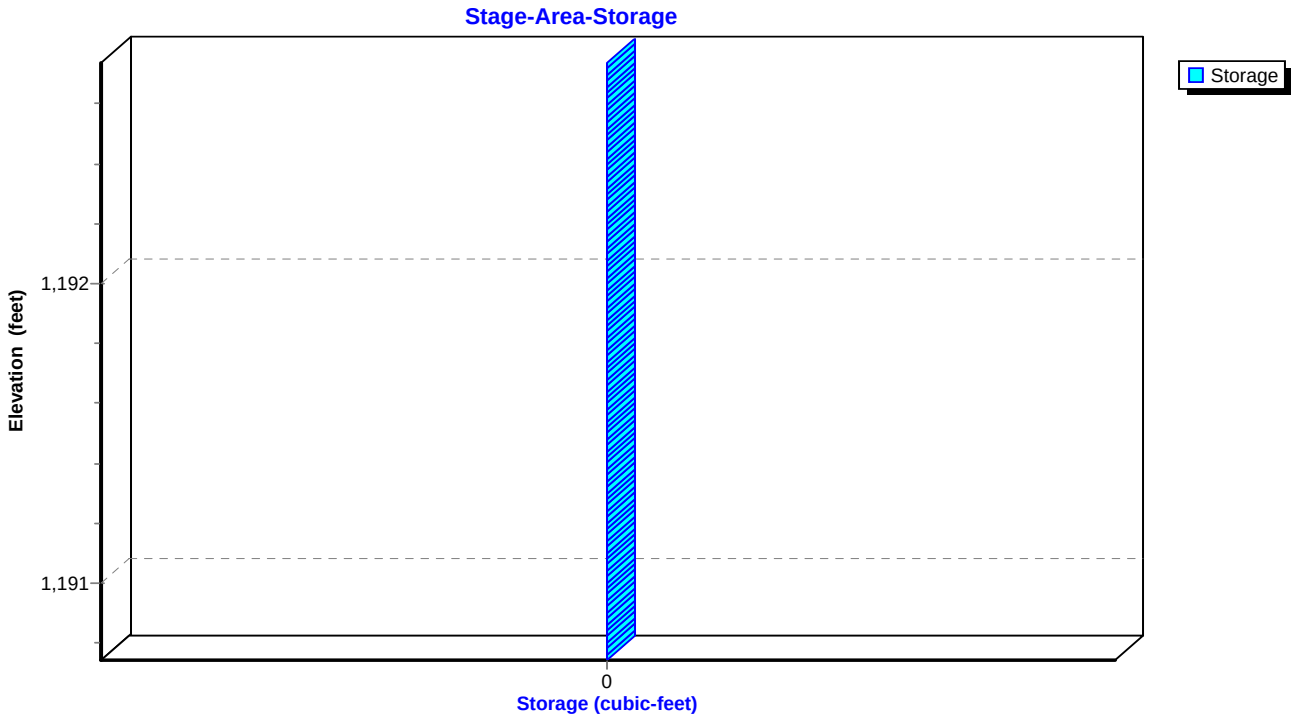
Pond Ch: Channel to Tank



Pond Ch: Channel to Tank



Pond Ch: Channel to Tank



Summary for Pond T: TMF Tank

Storage dimensions are not actual tank dimensions, merely representative dimensions to achieve the same storage volume.

Float levels lowered: low float-1186 ft, high float 1188 ft

Flood Elevation represents water level at which barn flooding would begin to occur.

---

[99] Warning: Min. Lift of 10.08' is below pump rating
[80] Warning: Exceeded Pond Ch by 0.03' @ 12.10 hrs (9.75 cfs 0.099 af)

Inflow Area = 3.332 ac,100.00% Impervious, Inflow Depth = 4.86" for 25-Year event
Inflow = 22.54 cfs @ 11.97 hrs, Volume= 1.350 af
Outflow = 4.03 cfs @ 11.90 hrs, Volume= 1.334 af, Atten= 82%, Lag= 0.0 min
Primary = 4.03 cfs @ 11.90 hrs, Volume= 1.334 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 1,191.82' @ 12.19 hrs Surf.Area= 28,334 sf Storage= 18,048 cf
Flood Elev= 1,192.73' Surf.Area= 57,147 sf Storage= 56,757 cf

Plug-Flow detention time= 53.8 min calculated for 1.334 af (99% of inflow)
Center-of-Mass det. time= 45.7 min (790.1 - 744.4)

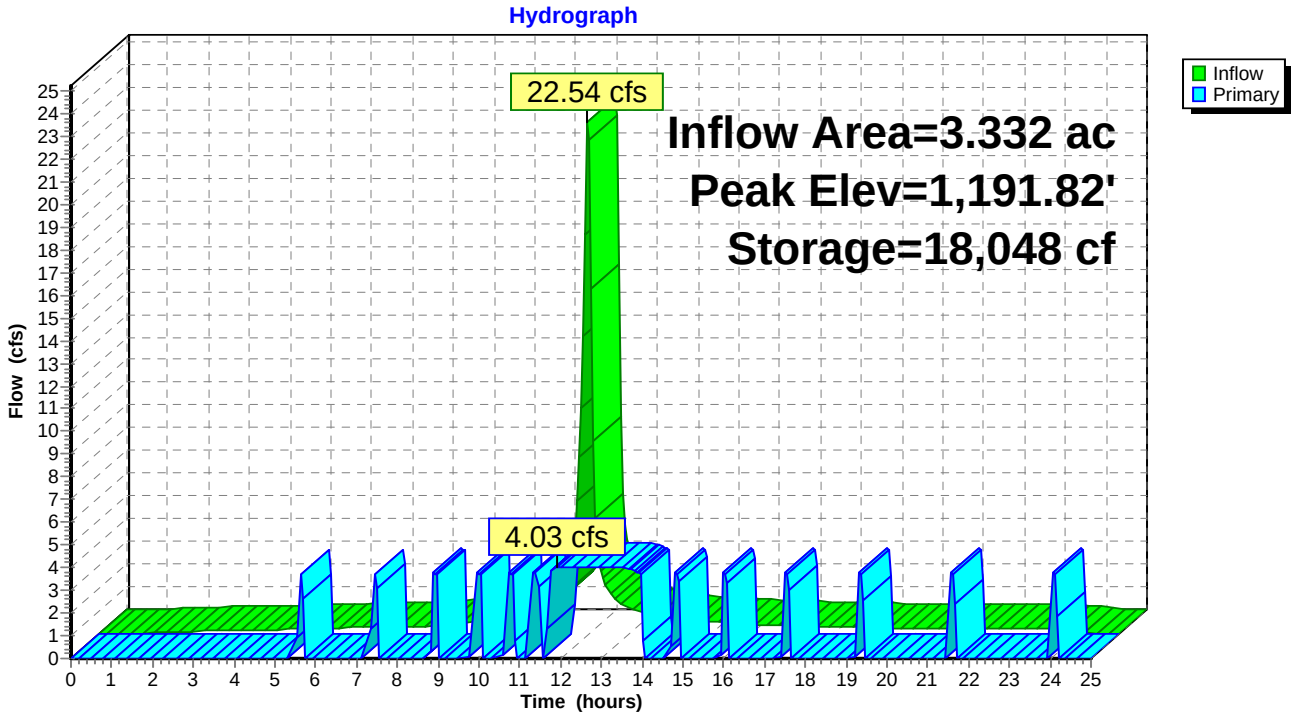
Volume	Invert	Avail.Storage	Storage Description
#1	1,184.72'	56,757 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,184.72	0	0	0
1,184.73	673	3	3
1,190.73	823	4,488	4,491
1,190.92	1,268	199	4,690
1,191.92	31,258	16,263	20,953
1,192.73	57,147	35,804	56,757

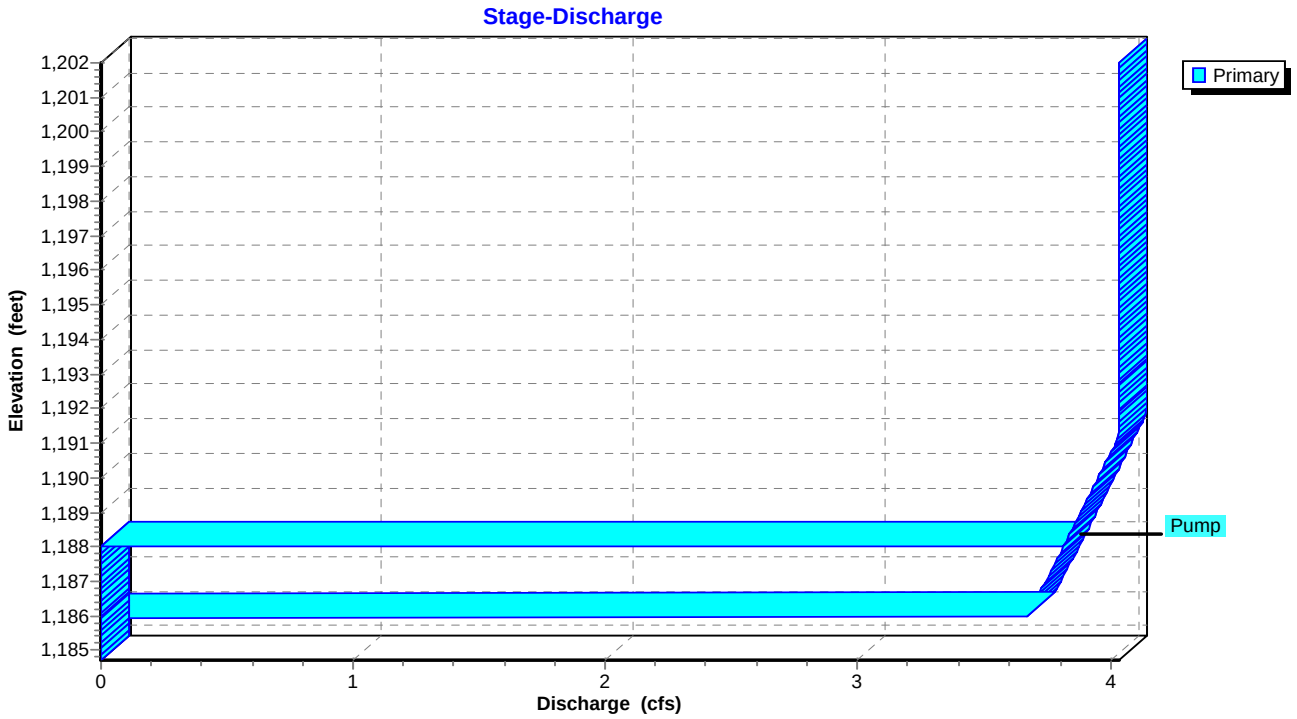
Device	Routing	Invert	Outlet Devices
#1	Primary	1,188.00'	**Pump** Discharges@1,202.00' Turns Off@1,186.00' 12.0" Diam. x 1,469.5' Long Discharge, Hazen-Williams C= 130 Flow (gpm)= 1,420.0 1,521.0 1,620.0 1,717.0 1,811.0 Head (feet)= 30.00 28.00 26.00 24.00 22.00 -Loss (feet)= 7.13 8.10 9.11 10.14 11.19 =Lift (feet)= 22.87 19.90 16.89 13.86 10.81

Primary OutFlow Max=4.03 cfs @ 11.90 hrs HW=1,191.31' (Free Discharge)
1=Pump (Pump Controls 4.03 cfs)

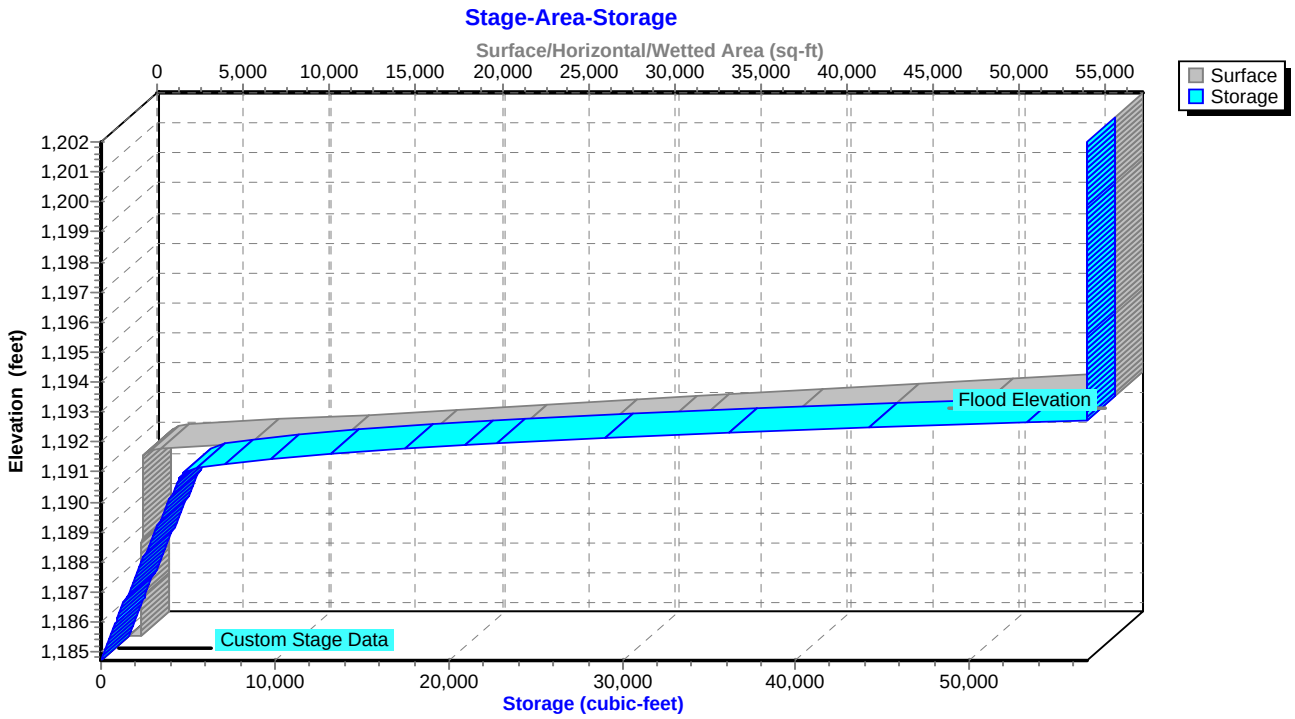
Pond T: TMF Tank

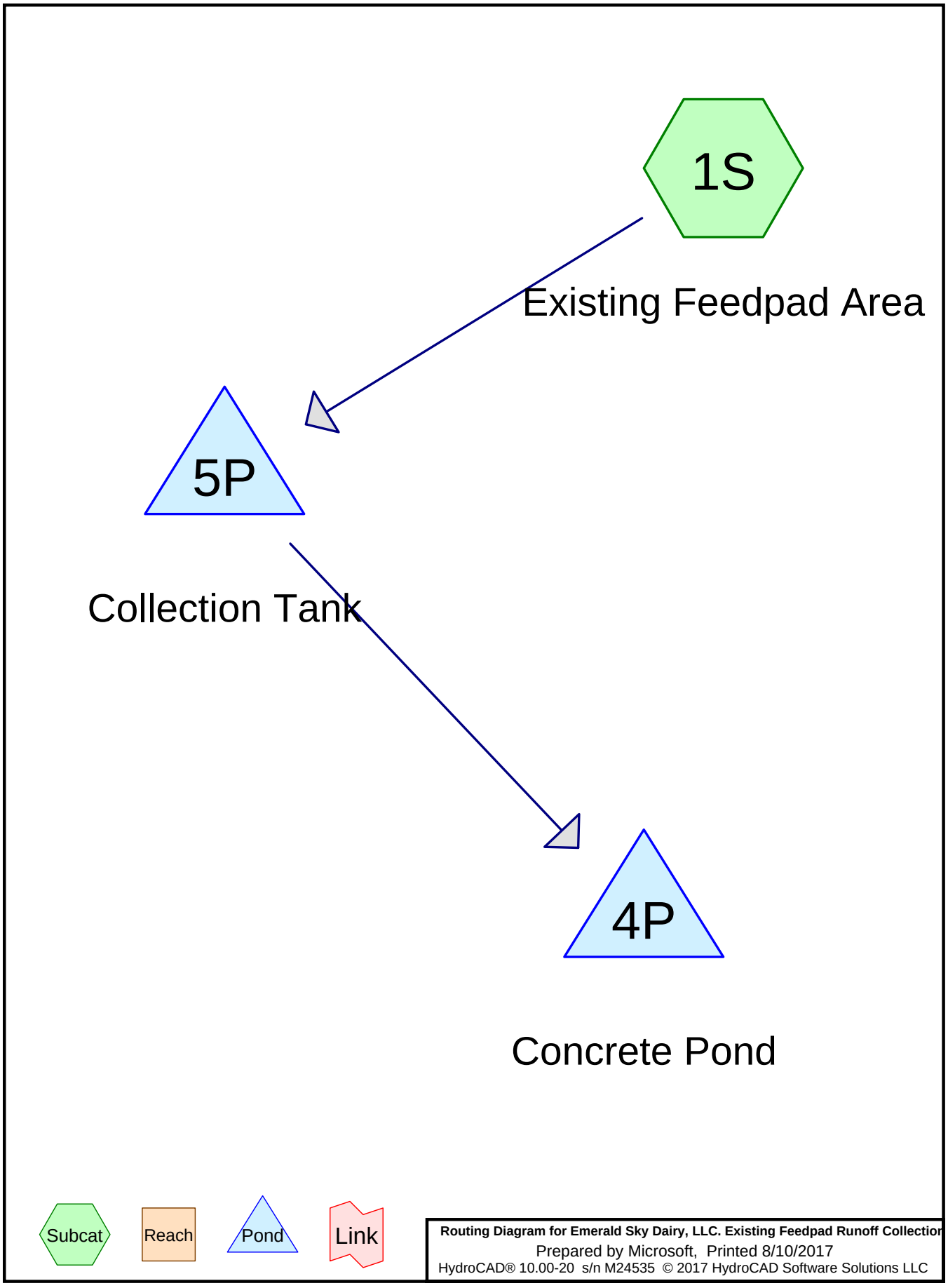


Pond T: TMF Tank



Pond T: TMF Tank




1S
Existing Feedpad Area
5P
Collection Tank
4P
Concrete Pond
Subcat
Reach
Pond
Link
Routing Diagram for Emerald Sky Dairy, LLC. Existing Feedpad Runoff Collection
Prepared by Microsoft, Printed 8/10/2017
HydroCAD® 10.00-20 s/n M24535 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.470	98	Feedpad Slab (1S)
2.470	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
2.470	Other	1S
2.470		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	2.470	2.470	Feedpad Slab	1S
0.000	**0.000**	**0.000**	**0.000**	**2.470**	**2.470**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	5P	1,199.00	1,196.68	463.3	0.0050	0.012	24.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.03 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Feedpad Area Runoff Area=2.470 ac 100.00% Impervious Runoff Depth>4.67"
Flow Length=528' Slope=0.0290 '/' Tc=2.5 min CN=98 Runoff=20.57 cfs 0.961 af

Pond 4P: Concrete Pond Peak Elev=1,183.93' Storage=41,808 cf Inflow=19.24 cfs 0.960 af
Outflow=0.00 cfs 0.000 af

Pond 5P: Collection Tank Peak Elev=1,202.42' Storage=933 cf Inflow=20.57 cfs 0.961 af
24.0" Round Culvert n=0.012 L=463.3' S=0.0050 '/' Outflow=19.24 cfs 0.960 af

Total Runoff Area = 2.470 ac Runoff Volume = 0.961 af Average Runoff Depth = 4.67"
0.00% Pervious = 0.000 ac 100.00% Impervious = 2.470 ac

Summary for Subcatchment 1S: Existing Feedpad Area

[49] Hint: Tc<2dt may require smaller dt

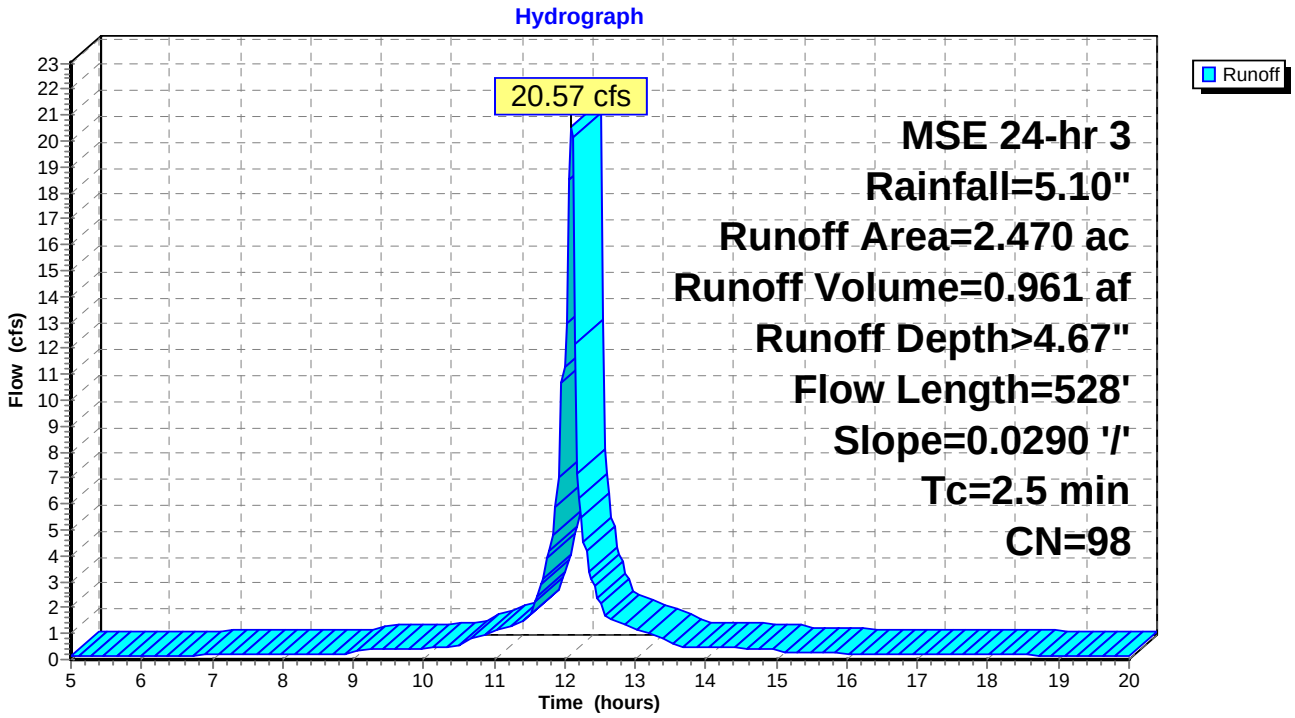
Runoff = 20.57 cfs @ 12.09 hrs, Volume= 0.961 af, Depth> 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.03 hrs
MSE 24-hr 3 Rainfall=5.10"

	Area (ac)	CN	Description
*	2.470	98	Feedpad Slab
	2.470		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	528	0.0290	3.46		**Shallow Concentrated Flow, Existing Asphalt Pad** Paved Kv= 20.3 fps

Subcatchment 1S: Existing Feedpad Area



Summary for Pond 4P: Concrete Pond

Inflow Area = 2.470 ac,100.00% Impervious, Inflow Depth > 4.66"
Inflow = 19.24 cfs @ 12.11 hrs, Volume= 0.960 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

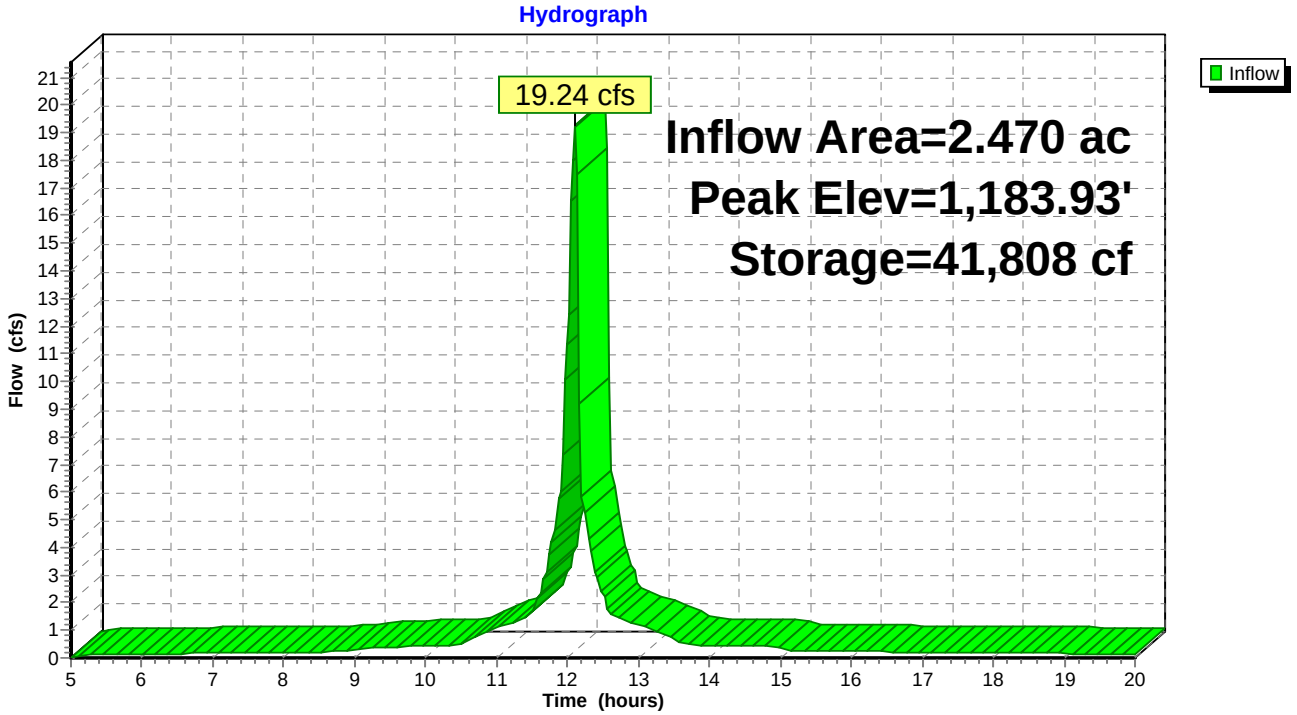
Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.03 hrs
Peak Elev= 1,183.93' @ 20.00 hrs Surf.Area= 12,925 sf Storage= 41,808 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

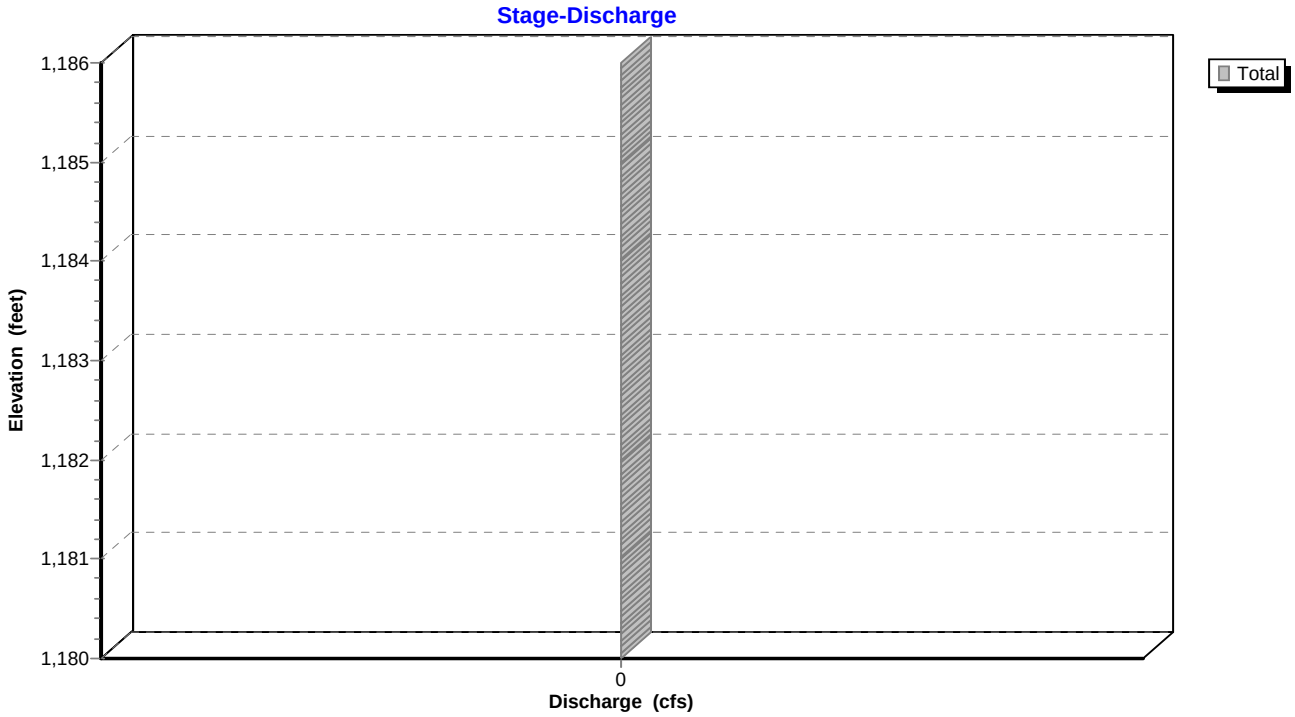
Volume	Invert	Avail.Storage	Storage Description
#1	1,180.00'	71,227 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,180.00	8,444	0	0
1,181.00	9,522	8,983	8,983
1,182.00	10,642	10,082	19,065
1,183.00	11,805	11,224	30,289
1,184.00	13,007	12,406	42,695
1,185.00	14,260	13,634	56,328
1,186.00	15,537	14,899	71,227

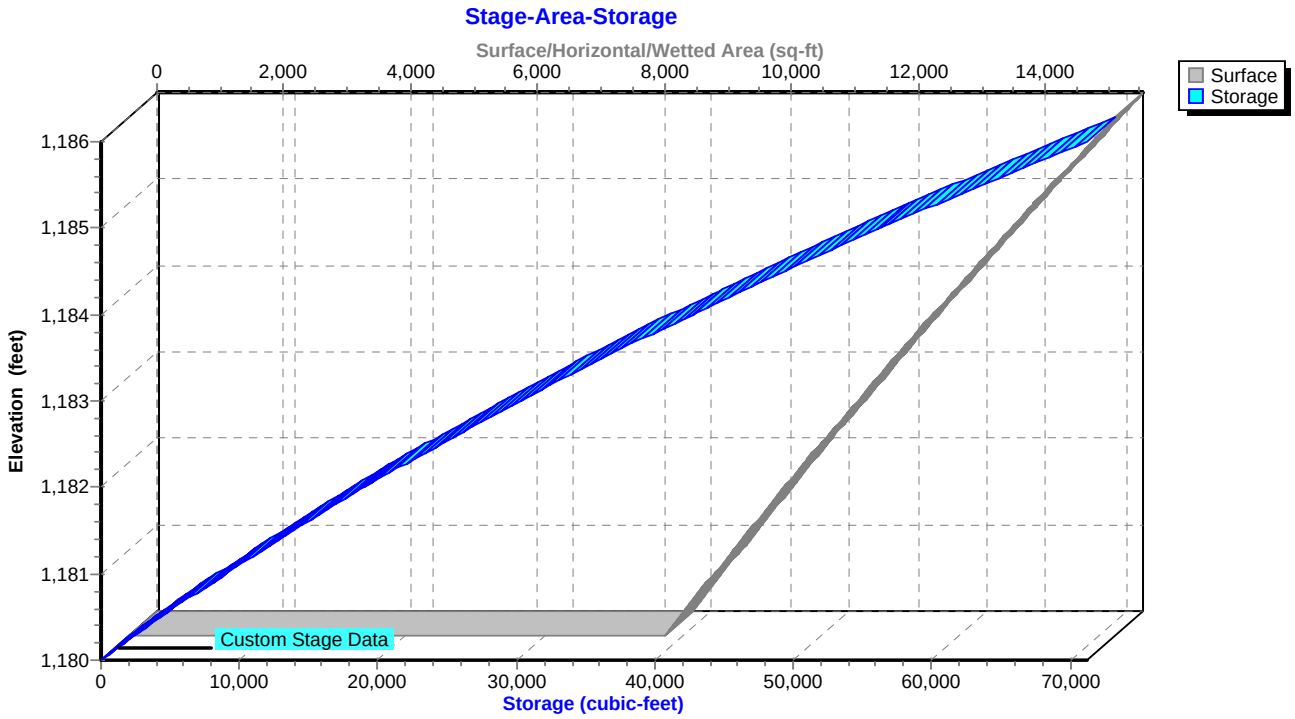
Pond 4P: Concrete Pond



Pond 4P: Concrete Pond



Pond 4P: Concrete Pond



Summary for Pond 5P: Collection Tank

[82] Warning: Early inflow requires earlier time span

Inflow Area = 2.470 ac,100.00% Impervious, Inflow Depth > 4.67"
Inflow = 20.57 cfs @ 12.09 hrs, Volume= 0.961 af
Outflow = 19.24 cfs @ 12.11 hrs, Volume= 0.960 af, Atten= 6%, Lag= 1.0 min
Primary = 19.24 cfs @ 12.11 hrs, Volume= 0.960 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.03 hrs
Peak Elev= 1,202.42' @ 12.11 hrs Surf.Area= 390 sf Storage= 933 cf

Plug-Flow detention time= 1.4 min calculated for 0.958 af (100% of inflow)
Center-of-Mass det. time= 1.0 min (733.3 - 732.4)

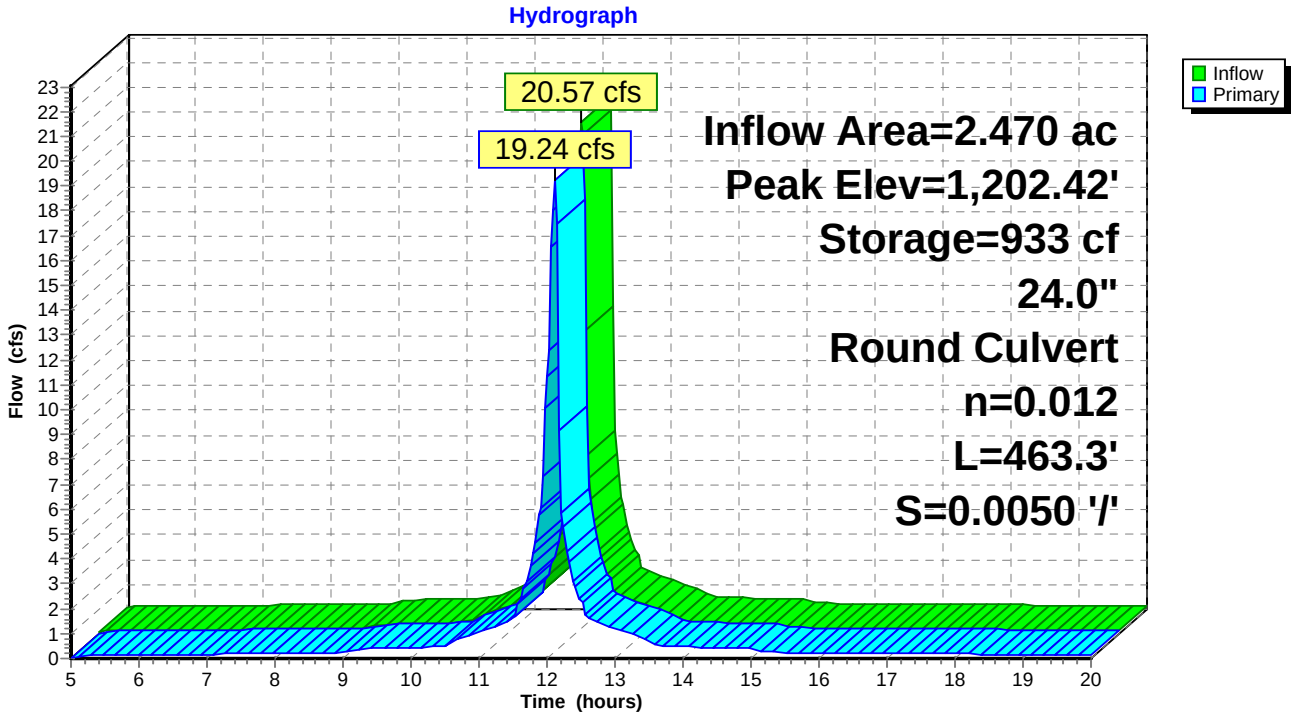
Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	1,164 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,199.00	151	0	0
1,200.00	221	186	186
1,201.00	291	256	442
1,202.00	361	326	768
1,203.00	430	396	1,164

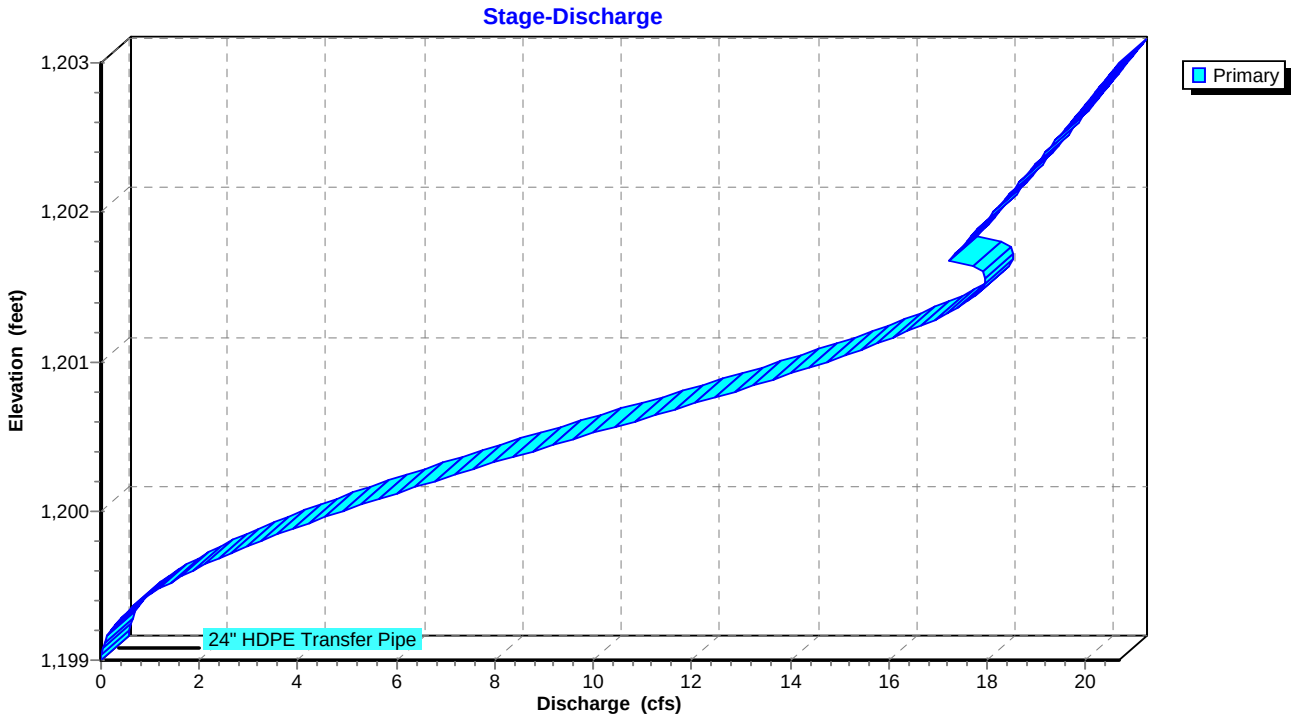
Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.00'	**24.0" Round 24" HDPE Transfer Pipe** L= 463.3' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 1,199.00' / 1,196.68' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Primary OutFlow Max=19.12 cfs @ 12.11 hrs HW=1,202.37' (Free Discharge)
1=24" HDPE Transfer Pipe (Barrel Controls 19.12 cfs @ 6.09 fps)

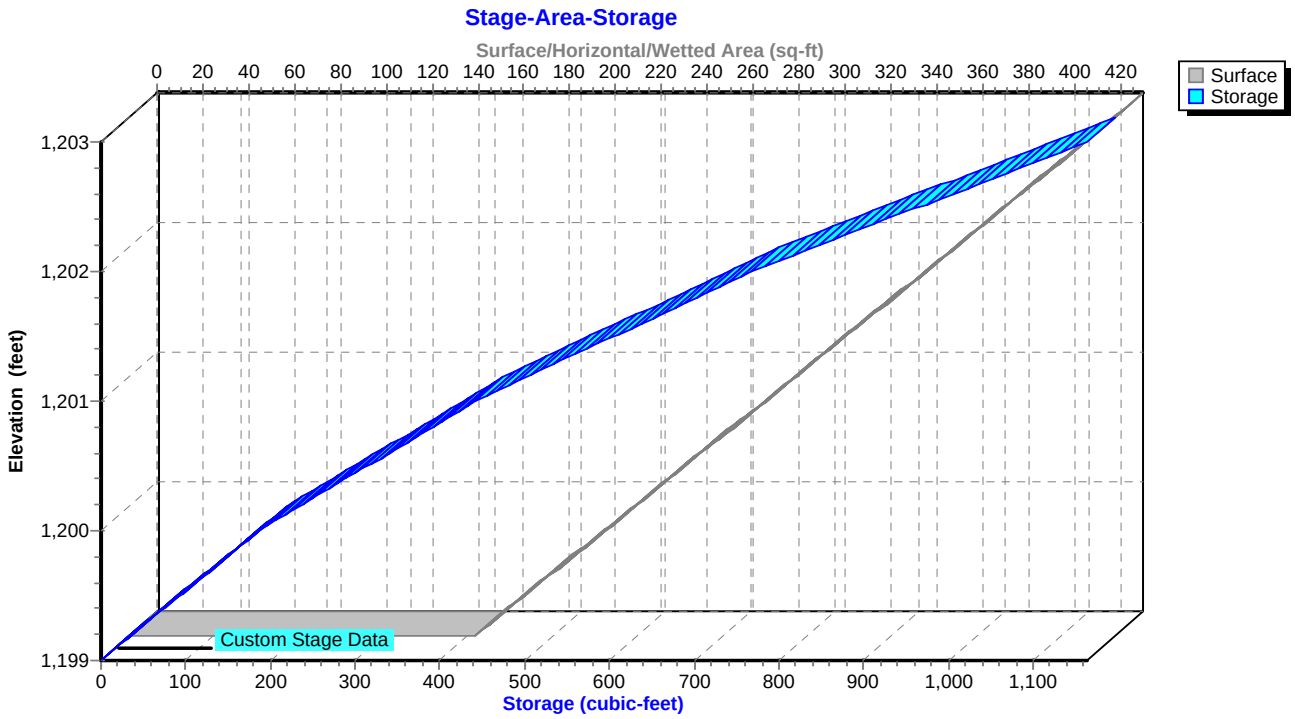
Pond 5P: Collection Tank



Pond 5P: Collection Tank



Pond 5P: Collection Tank



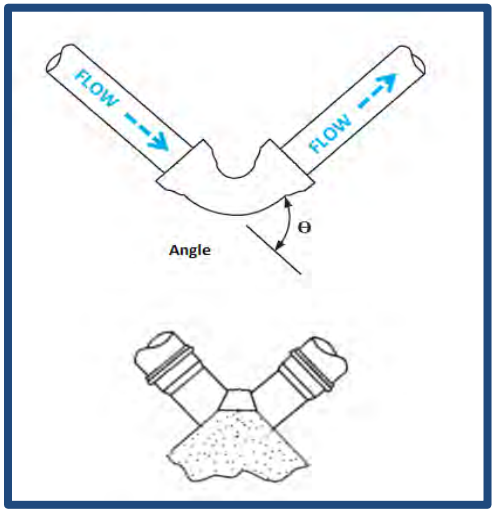
CONCRETE THRUST BLOCK DESIGN

v. 3-2013

CLIENT:	Emerald Sky Dairy, LLC	COUNTY:	ST. CROIX	DATE:	8/7/2017
DSN BY:	Cody Overgard	CHK BY:		DATE:	
COMMENTS:	8" and 12" Transfer Pipes and Elbows				

Thrust Blocks for Pipe Angles

$$A_T = \frac{2Pa\sin(\frac{\theta}{2})}{q_{all}}$$



Where:

A_T = Area of thrust block required (ft^2)

P = Working pressure (lb/in^2)

a = cross section area of the pipe (in^2)

ɵ = angle of pipe bend (degrees)

q_{all} = Allowable bearing pressure of the soil (lb/ft^2)

INPUTS

Working Pressure (lb/in^2)	60	**L (in)**	**28.0**
Inside Pipe Diameter (inches)	12	**W (in)**	**17.0**
Deflection angle of pipe bend (degrees)	45		
Allowable Soil Bearing Pressure {from soil test or from Table 1 below} (lb/ft^2)	1650		

Area of Thrust Block Required	**3.1 sq ft**
Min. Volume of Concrete**	**0.29 cu yd**

**Cast in place concrete requires minimum thickness of 8" around pipe.

Table 52-6 (of NEH Part 636.5207) - Allowable Soil Bearing Pressure

Natural soil material	**Depth of cover to center of thrust block** 2 ft	3 ft	4 ft	5 ft
			lb/ft^2	
Sound Bedrock	8,000	10,000	10,000	10,000
Dense sand and gravel mixture (assumed θ=40°)	1,200	1,800	2,400	3,000
Dense fine to coarse sand (assumed θ=35°)	800	1,200	1,650	2,100
Silt and clay mixture (assumed θ=25°)	500	700	950	1,200