INSTALLATION OVERVIEW

FOUNDATION, TRENCHWALL, BEDDING, AND BACKFILL CONSIDERATIONS FOR MULTIPLE BARREL DETENTION AND RETENTION SYSTEMS ARE NOT UNLIKE THOSE FOR CONVENTIONAL CORRUGATED METAL PIPE (CMP) INSTALLATION. HOWEVER, PLACEMENT AND COMPACTION CONSIDERATIONS DIFFER SUBSTANTIALLY. CONSTRUCTION OFTEN MUST PROCEED IN A DIFFERENT MANNER MAKING THE USE OF DIFFERENT MATERIALS AND METHODS ADVISABLE TO ACHIEVE A SOUND, ECONOMICAL RESULT. WHILE THIS DESIGN MANUAL COVERS MANY OF THE PROCEDURES THAT MUST BE FOLLOWED, THERE MAY BE CASES THAT REQUIRE ADDITIONAL CONSIDERATIONS. IT IS ALWAYS A GOOD PRACTICE TO CONSULT WITH YOUR LOCAL TRUENORTH STEEL REPRESENTATIVE PRIOR TO THE INSTALLATION OF THESE SYSTEMS. THE FOLLOWING AREAS SHOULD BE CONSIDERED AND PLANNED FOR EACH ON EACH INSTALLED SYSTEM: FOUNDATION, BEDDING, IN-SITU TRENCH WALL, BACKFILL MATERIAL, BACKFILL PLACEMENT, FLOATATION, CONSTRUCTION LOADING, AND INSPECTION AND MAINTENANCE.

FOUNDATION CONSIDERATIONS

A STABLE FOUNDATION MUST BE CONSTRUCTED PRIOR TO PLACEMENT OF THE BEDDING MATERIAL. IT IS IMPORTANT THAT THE FOUNDATION IS NOT ONLY CAPABLE OF SUPPORTING THE DESIGN LOAD APPLIED BY THE PIPE AND IT'S ADJACENT BACKFILL WEIGHT BUT IS ALSO CAPABLE OF MAINTAINING IT'S INTEGRITY DURING THE CONSTRUCTION SEQUENCE.

WHEN SOFT OR UNSUITABLE SOILS ARE ENCOUNTERED, CORRECTIVE MEASURES MUST BE TAKEN. THE UNSUITABLE MATERIAL NEEDS TO BE REMOVED DOWN TO A SUITABLE DEPTH AND THEN BUILT UP TO THE APPROPRIATE ELEVATION WITH A SUITABLE STRUCTURAL BACKFILL MATERIAL. IT IS IMPORTANT TO MAKE SURE THAT THIS ADDED STRUCTURAL FILL MATERIAL HAS A GRADATION THAT WILL NOT ALLOW FOR THE MIGRATION OF FINES, CAUSING POSSIBLE SETTLEMENT OF THE DETENTION / RETENTION SYSTEM OR THE PAVEMENT ABOVE. IN CASES WHERE THE STRUCTURAL FILL MATERIAL IS NOT COMPATIBLE WITH THE UNDERLYING SOILS, AN ENGINEERING FABRIC CAN BE USED AS A SEPARATOR.

THE FOUNDATION SUB-GRADE SHOULD BE GRADED TO A UNIFORM OR SLIGHTLY SLOPING GRADE PRIOR TO THE PLACEMENT OF THE BEDDING MATERIAL. IF THE SUB-GRADE IS A CLAY OR IS RELATIVELY NON-POROUS AND THE CONSTRUCTION SEQUENCE WILL LAST FOR AN EXTENDED PERIOD OF TIME, IT IS BEST TO SLOPE THE GRADE TO THE OUTLET END OF THE SYSTEM. THIS WILL ENABLE EXCESS WATER TO BE DRAINED QUICKLY, PREVENTING SATURATION OF THE SUBGRADE.

BEDDING CONSIDERATIONS

A WELL-GRADED GRANULAR MATERIAL PLACED A MINIMUM OF 4-6 INCHES IN DEPTH WORKS BEST FOR THE BEDDING (FIGURE A). IN THE EVENT THAT A FILTRATION SYSTEM IS BEING DESIGNED, WHICH COMMONLY HAS A SAND FILTRATION LAYER BENEATH THE PIPES, THIS LAYER MAY SERVE AS AN ADEQUATE BEDDING LAYER PENDING A SEPARATION FABRIC IS USED BETWEEN THE STONE LAYER (WHICH IS DESIGNED TO STORE ADDITIONAL WATER IN IT'S VOID SPACES) AND THE SAND LAYER. IF CONSTRUCTION EQUIPMENT IS EXPECTED TO OPERATE FOR AN EXTENDED PERIOD OF TIME ON THE BEDDING, AN ENGINEERING FABRIC CAN BE USED TO MAKE SURE THE BEDDING MATERIAL MAINTAINS IT'S INTEGRITY. THE USE OF AN OPEN GRADED BEDDING MATERIAL IS ACCEPTABLE; HOWEVER, AN ENGINEERING FABRIC SEPARATOR IS REQUIRED BETWEEN THE BEDDING AND THE SUBGRADE. THE BEDDING SHOULD BE GRADED TO A SMOOTH CONSISTENT UNIFORM GRADE TO ALLOW FOR PLACEMENT OF THE PIPE ON THE PROPER LINE AND GRADE.

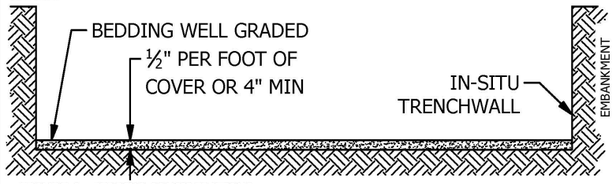

FIGURE A : BEDDING CONSIDERATIONS

IN-SITU TRENCH WALL CONSIDERATIONS

IN THE EVENT THAT EXCAVATION IS REQUIRED TO GET THE PIPE PLACED ON THE PROPER LINE AND GRADE, CONSIDERATION NEEDS TO BE GIVEN TO THE QUALITY OF THE SURROUNDING IN-SITU SOIL (FIGURE B). THE TRENCH WALL MUST BE STABLE AND CAPABLE OF SUPPORTING THE LOAD THAT THE PIPE SHEDS AS THE SYSTEM IS LOADED. SOILS THAT ARE WEAK AND NOT CAPABLE OF SUPPORTING THESE LOADS WILL ALLOW THE PIPE TO DEFLECT EXCESSIVELY. A SIMPLE SOIL PRESSURE CHECK WILL PROVIDE THE DESIGNER WITH THE APPLIED LOADS THAT CAN BE USED TO DETERMINE THE LIMITS OF EXCAVATION REQUIRED BEYOND THE SPRING LINE OF THE OUTERMOST PIPES. IT SHOULD BE NOTED THAT IN MOST CASES, THE REQUIREMENTS FOR PROVIDING A SAFE WORK ENVIRONMENT AND ENOUGH SPACE FOR PROPER BACKFILL PLACMENT AND COMPACTION DO TAKE CARE OF THIS CONCERN.

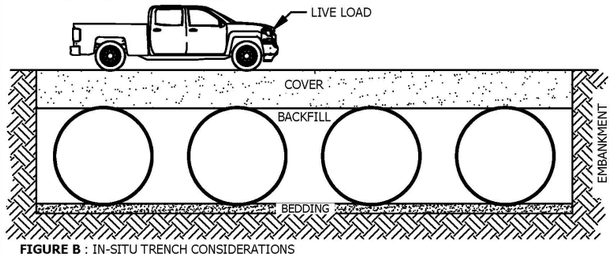

FIGURE B : IN-SITU TRENCH CONSIDERATIONS

BACKFILL MATERIAL CONSIDERATIONS

ALL OTHER CONSIDERATIONS ASIDE, THE BEST BACKFILL MATERIAL IS AN ANGULAR, CLEAN, WELL-GRADED GRANULAR FILL MEETING THE REQUIREMENTS OF AASHTO A-1-A. HOWEVER, OTHER BACKFILL TYPES CAN BE USED (CONSULT TRUENORTH STEEL) AND MAY BE NECESSARY (LIKE IN THE EVENT A RETENTION SYSTEM IS BEING DESIGNED). IF A UNIFORMLY GRADED (PARTICLES ALL ONE SIZE) BEDDING IS USED, THEN A GEOTEXTILE SEPARATION FABRIC SHOULD BE USED TO PREVENT THE MIGRATION OF FINES (FIGURE C)

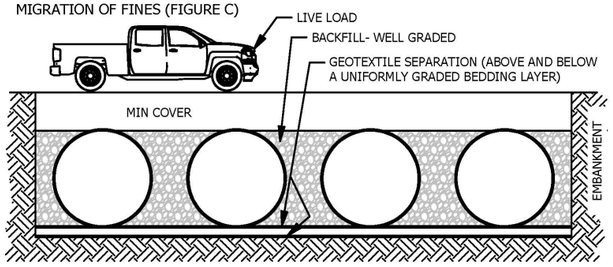

FIGURE C : BACKFILL CONSIDERATIONS

DEPENDING ON THE SIZE OF THE PIPE AND THE SPACING, IT IS AT TIMES DESIRABLE TO USE A UNIFORMLY GRADED MATERIAL FOR THE FIRST 18-24 INCHES. THIS TYPE OF MATERIAL IS EASIER TO PLACE UNDER THE HAUNCHES OF THE PIPE AND REQUIRES LITTLE COMPACTION EFFORT. IN THE EVENT THAT THIS TYPE OF MATERIAL IS USED, THEN A SEPARATION GEOTEXTILE SHOULD BE USED ABOVE AND BELOW THESE INITIAL LIFTS, DEPENDING AGAIN ON THE BEDDING MATERIAL (FIGURE D).

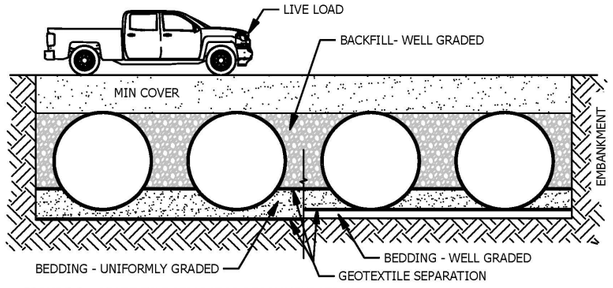

FIGURE D : GEOTEXTILE SEPARATOR RECOMMENDATIONS

IT IS NOT DESIRABLE TO USE AN OPEN GRADED FILL BEYOND THE INITIAL 18-24 INCHES BECAUSE THIS PROPOSED FILL OFTEN DOES NOT PROVIDE ADEQUATE CONFINING RESTRAINT TO THE PIPES IN THESE TYPES OF SYSTEMS. FIGURE E SHOWS BACKFILL WITH CLSM, ANOTHER SUITABLE MATERIAL.

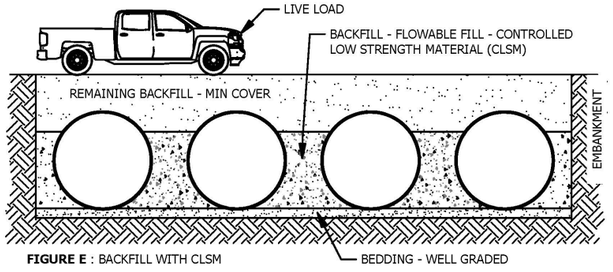

FIGURE E : BACKFILL WITH CLSM

BACKFILL PLACEMENT CONSIDERATIONS

THE BACKFILL SHOULD BE PLACED IN 6 TO 8 INCH LOOSE LIFTS AND COMPACTED TO 90% AASHTO T99 STANDARD PROCTOR DENSITY. THE BACKFILL MUST BE PLACED IN A BALANCED MANNER MAKING SURE THAT NO MORE THAN A TWO LIFT DIFFERENTIAL IS PRESENT FROM ONE PIPE SIDE TO THE OTHER DURING THE BACKFILLING PROCESS. EXCESSIVE BACKFILL DIFFERENTIAL HEIGHTS FROM ONE SIDE OF THE PIPE TO THE OTHER CAN CAUSE PIPE DISTORTION OR LATERAL MOVEMENT. AS BACKFILL IS PLACED BETWEEN THE PIPES, IT MUST BE KEPT BALANCED FROM SIDE TO SIDE AS WELL AS ADVANCED AT THE SAME RATE ALONG THE LENGTH OF THE DETENTION / RETENTION SYSTEM. IN OTHER WORDS, IF YOU PLACE THE FIRST LIFT BETWEEN PIPE A AND B FOR A DISTANCE OF 25 FEET ALONG THE LENGTH OF THE SYSTEM, THEN 25 FEET OF FILL NEEDS TO BE PLACED BETWEEN PIPES B AND C AND SO FORTH UNTIL ALL PIPES ARE BACKFILLED EQUALLY (FIGURE F).

TYPICAL BACKFILL SEQUENCE

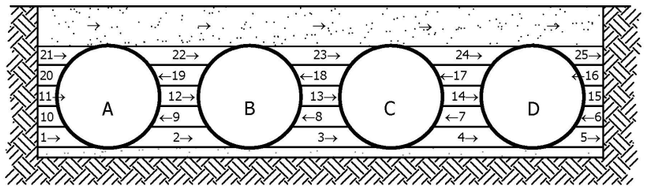

FIGURE F : BACKFILL PLACEMENT SEQUENCE

BACKFILL PLACEMENT CONSIDERATIONS CONT'D

FOR LARGE SYSTEMS, CONVEYOR SYSTEMS HAVE BEEN USED TO PLACE THE FILL EFFECTIVELY. BACKHOES WITH LONG REACHES OR DRAGLINES WITH STONE BUCKETS HAVE ALSO BEEN USED EFFECTIVELY TO PLACE THE FILL ALONG THE PIPE LENGTHS UNTIL MINIMUM COVER IS REACHED FOR CONSTRUCTION LOADING ACROSS THE ENTIRE WIDTH OF THE SYSTEM. ON LONG PARALLEL SECTIONS OF PIPE, THE CONTRACTOR MAY NEED TO BACKFILL IN STAGES ALONG THE PIPE LENGTHS. ONCE THE REQUIRED COVER IS REACHED ON THE INITIAL SECTION, THEN THE EQUIPMENT ADVANCES FORWARD TO THE END OF THE RECENTLY PLACED FILL AND THE SEQUENCE BEGINS OVER AGAIN UNTIL THE SYSTEM IS COMPLETELY BACKFILLED. THIS TYPE OF CONSTRUCTION SEQUENCE WILL PROVIDE ROOM FOR STOCKPILED BACKFILL DIRECTLY BEHIND THE BACKHOE AS WELL AS FOR THE MOVEMENT OF CONSTRUCTION TRAFFIC. MATERIAL STOCKPILES ON TOP OF THE BACKFILLED DETENTION / RETENTION SYSTEM SHOULD BE LIMITED TO 8-10 FEET MAXIMUM HEIGHT AND MUST PROVIDE BALANCED LOADING ACROSS ALL BARRELS. TO DETERMINE THE PROPER COVER OVER THE PIPES TO ALLOW THE MOVEMENT OF CONSTRUCTION EQUIPMENT, SEE THE SECTION THAT FOLLOWS, CONSTRUCTION LOADING CONSIDERATIONS.

THE TRENCH WIDTH AND PIPE SPACING REQUIREMENTS WERE ESTABLISHED TO ALLOW THE FULL RANGE OF BACKFILL MATERIALS TO BE USED. THESE SPACINGS CAN BE REDUCED WHEN A SPECIAL BACKFILL AND SPECIAL CARE IS USED. THE LIMIT IS WHERE THE DIFFICULTY OF ACCESS FOR ASSEMBLY AND BACKFILL COMPACTION BECOMES UNECONOMICAL.

REDUCING THE SPACING BETWEEN PIPES CAN BE ESPECIALLY HELPFUL WHERE THE MULTIPLE RUNS OFTEN INVOLVED WITH DETENTION / RETENTION SYSTEMS ARE ENCOUNTERED. THESE ARE TYPICALLY LOW COVER APPLICATIONS WHERE STRENGTH OF THE BACKFILL IS LESS IMPORTANT AND HIGH COMPACTION IS NOT AS CRITICAL. CLEAN, NON-PLASTIC, EASILY FLOWING BACKFILL MATERIALS HAVE HIGHER STRENGTHS THAN OTHER BACKFILL MATERIALS, EVEN AT LOWER COMPACTION LEVELS.

A SPACING OF 24 INCHES IS GENERALLY NOT OBJECTIONABLE. A SPACING OF 18 INCHES OR LESS CAN BE USED WITH BACKFILL MATERIALS SUCH AS CRUSHED ROCK, #57 STONE, OR PEA GRAVEL. THESE MATERIALS ARE MORE EASILY PLACED INTO THE HAUNCH. WHEN NECESSARY, CONCRETE VIBRATORS CAN BE USED TO MOVE AND CONSOLIDATE THE BACKFILL MUCH LIKE THEY DO FLUID CONCRETE, TO ASSURE THERE ARE NO VOIDS LEFT. ALTERNATIVELY, CONVENTIONAL VIBRATORY COMPACTION PLATES HAVE BEEN USED INSIDE THE PIPE INVERT TO HELP MOVE AND CONSOLIDATE THESE MATERIALS AGAINST THE OUTSIDE OF THE PIPE.

LOW STRENGTH GROUT, CONTROLLED LOW STRENGTH MATERIALS (CLSM), ETC. ALLOW SPACING OF AS LITTLE AS SIX INCHES IF PIPES CAN BE JOINED. HOWEVER, FLOATATION BECOMES A SPECIAL CONSIDERATION AND MAY REQUIRE THE PIPE TO BE WEIGHTED OR TIED DOWN (FIGURE G).

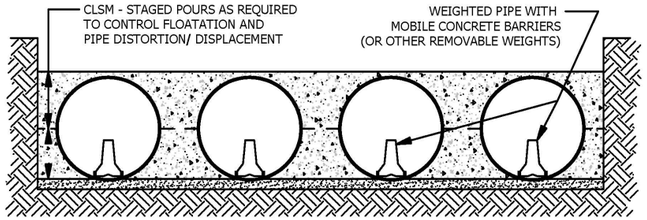

FIGURE G : STAGED POURS FOR CLSM - CONTROLLING FLOTATION

This document reflects best practices in accordance NCSPA Design Manual Chapter 10: Installation & Construction Procedures.

FLOTATION

WHEN CMP RELINE PIPES OR THOSE BACKFILLED WITH GROUT ARE INSTALLED, A PRIMARY CONSIDERATION IS THE NEED TO CONTROL FLOTATION. FLUID GROUT, WHICH MAY HAVE A DENSITY OF 120 PCF OR GREATER CAN DEVELOP GREATER BUOYANCY FORCES THAN WATER. TO MINIMIZE FLOATATION PROBLEMS, GROUT IS TYPICALLY PLACED IN THIN LIFTS FROM SIDE TO SIDE OF THE PIPES IN A BALANCED MANNER.

DIRECT BURIAL PIPES ARE TYPICALLY MORE DIFFICULT TO HOLD DOWN. METHODS THAT HAVE BEEN USED TO PROVIDE A DEGREE OF HOLD DOWN RESTRAINT INCLUDE PLACING TIMBERS OVER THE PIPE WITH EACH END WEDGED INTO THE TRENCH WALL OR PLACING TENSION STRAPS OVER THE PIPE CROWN TIED TO EARTH ANCHORS IN THE FOUNDATION. WHERE FEASIBLE, PIPES HAVE BEEN FILLED WITH WATER OR WEIGHED DOWN WITH CONCRETE BLOCKS PLACED ON ROLLER DOLLIES IN THE INVERT. WHERE THE HOLD DOWN RESTRAINTS ARE INTERMITTENT, SUPPORT SPACING LIMITS DO APPLY. HOWEVER, IT MUST BE RECOGNIZED THAT THE AERIAL SPAN LIMITS APPLY TO WATER FILLED PIPES WHEREAS INUNDATING THE ENTIRE PIPE WITH GROUT COULD DEVELOP ROUGHLY TWICE THE UPLIFT, DUE TO THE HIGHER GROUT DENSITY. ONE WAY TO REDUCE THE BUOYANT FORCES IS THE USE OF LIGHTWEIGHT CEMENTITIOUS BACKFILL MATERIALS. THESE ARE OFTEN SIMPLY PORTLAND CEMENT, WATER, AND A FOAMING AGENT THAT, AT 30 TO 40 POUNDS PER CUBIC FOOT, PROVIDE EXCELLENT BACKFILL AND LOWER BUOYANCY FORCES THAN LOW STRENGTH GROUT. WHILE THESE SPECIAL BACKFILL MATERIALS ARE MORE COSTLY, THE CLOSER PIPE SPACINGS REDUCE THE NECESSARY QUANTITY.

SINCE MOST OF THESE SYSTEMS (DETENTION/RETENTION) ARE CONSTRUCTED AT A GRADE BELOW ELEVATION FOR THE SURROUNDING SITE, RAINFALL CAN CAUSE THE EXCAVATION TO FILL WITH WATER RAPIDLY. THIS RAPID INFLUX OF WATER CAN POTENTIALLY CAUSE FLOATATION AND MOVEMENT OF THE PREVIOUSLY PLACED PIPES. TO HELP MITIGATE POTENTIAL PROBLEMS, IT IS BEST TO START THE SYSTEM AT THE OUTLET OR DOWNSTREAM END WITH THE OUTLET ALREADY CONSTRUCTED TO ALLOW A ROUTE FOR THE WATER TO ESCAPE. TEMPORARY DIVERSION MEASURES TO HANDLE FLOW MAY BE REQUIRED DUE TO THE RESTRICTED NATURE OF THE OUTLET PIPE.

CONSTRUCTION LOADING CONSIDERATIONS

TYPICALLY, THE MINIMUM COVER SPECIFIED FOR THE PROJECT IS FOR STANDARD AASHTO H20 OR HL93 LIVE LOADS. CONSTRUCTION LOADS CAN GREATLY EXCEED THOSE LOADS FOR WHICH THE PIPE IS DESIGNED IN IT'S COMPLETED STATE. IN MANY CASES, INCREASED TEMPORARY MINIMUM COVER REQUIREMENTS ARE NECESSARY TO FACILITATE CONSTRUCTION LOADING (REFER TO CONSTRUCTION LOADING TABLE). SINCE CONSTRUCTION EQUIPMENT VARIES FROM JOB TO JOB, IT IS BEST TO DISCUSS MINIMUM COVER REQUIREMENTS DURING CONSTRUCTION WITH THE CONTRACTOR AT THE PRE-CONSTRUCTION MEETING.

INSPECTION AND MAINTENANCE

DETENTION AND RETENTION SYSTEMS SHOULD BE INSPECTED AT REGULAR INTERVALS AND MAINTAINED (WHEN NECESSARY) TO ENSURE OPTIMAL PERFORMANCE IS NOT REDUCED. THE INSPECTION AND MAINTENANCE FREQUENCY WILL FLUCTUATE DEPENDING ON THE ENVIRONMENT, CONFIGURATION, AND SITE CONDITIONS.

INSPECTION IS THE KEY TO EFFECTIVE MAINTENANCE AND CAN BE EASILY PERFORMED. TRUENORTH STEEL RECOMMENDS QUARTERLY INSPECTIONS AS SEDIMENT DEPOSITION AND TRANSPORT MAY VARY FROM YEAR TO YEAR AND THESE INSPECTIONS WILL HELP INSURE THAT SYSTEMS ARE SUFFICIENTLY MAINTAINED. INSPECTIONS SHOULD BE PERFORMED MORE OFTEN WHEN THE SYSTEM IS NEAR AN EQUIPMENT WASH-DOWN AREA AND IN THE WINTER MONTHS IN CLIMATES WHERE SANDING OPERATIONS OCCUR WHICH MAY LEAD TO RAPID SEDIMENTATION BUILDUPS. A RECORD OF EACH INSPECTION SHOULD BE DOCUMENTED. SYSTEMS SHOULD BE CLEANED WHEN INSPECTION REVEALS THAT ACCUMULATED SEDIMENT OR TRASH HAS REACHED A POINT OF CONCERN WHERE CLOGGING THE DISCHARGE ORIFICE OR OTHER NEGATIVE EFFECTS COULD TRANSPIRE. TRUENORTH STEEL RECOMMENDS THAT ALL SYSTEMS BE DESIGNED WITH AN ACCESS OR INSPECTION PORT LOCATED IN CLOSE PROXIMITY TO ANY INLET/OUTLET STUBS OR ABOVE ANY CHAMBERS DESIGNED SPECIFICALLY FOR SEDIMENTATION ISOLATION. SHOULD IT BE NECESSARY TO GET INSIDE THE SYSTEM TO PERFORM MAINTENANCE ACTIVITIES, ALL APPROPRIATE PRECAUTIONS REGARDING CONFINED SPACE ENTRY AND OSHA REGULATIONS SHOULD BE FOLLOWED. CLEANING AND MAINTAINING AN UNDERGROUND DETENTION OR RETENTION SYSTEM IS EASIEST WHEN THERE IS NO FLOW ENTERING THE SYSTEM. FOR THIS REASON, IT IS A GOOD IDEA TO SCHEDULE MAINTENANCE DURING DRY WEATHER MONTHS. ACCUMULATED SEDIMENT AND TRASH CAN TYPICALLY BE REMOVED THROUGH THE MANHOLE POSITIONED OVER THE OUTLET ORIFICE. IF MAINTENANCE IS NOT PERFORMED AS RECOMMENDED, SEDIMENT AND TRASH MAY ACCUMULATE AND REDUCE OR PROHIBIT INTENDED FUNCTIONALITY. MANHOLE COVERS SHOULD BE SECURELY SEATED FOLLOWING ANY ACCESS OR EGRESS.

PRELIMINARY

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NOTE:
THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL RESTRICTIONS OR REGULATIONS. CONTACT YOUR LOCAL TRUENORTH STEEL REPRESENTATIVE FOR MODIFICATIONS.

TOLERANCES
± 1/4" UNLESS OTHERWISE NOTED

DRAWING IS NOT TO SCALE
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED
ALL WELDS MUST REPAIRED AFTER FABRICATION (PER ASTM 760)
PIPE LENGTHS HAVE A TOLERANCE OF ± 2"
PIPE DIAMETERS HAVE A TOLERANCE OF THE GREATER OF ± 1/2" or 1%
ALL ANGLES HAVE A TOLERANCE OF ± 3°

PROJ. NAME:
LOCATION:
CREATED BY:
DATE:
SHEET NO: 5