1. GENERAL

1.1. INSTALLATION PRACTICES RELATED HEREIN APPLY TO PIPE MANUFACTURED IN ACCORDANCE WITH AASHTO M294 AND AASHTO M330, CORRUGATED HDPE AND POLYPROPYLENE PIPE, RESPECTIVELY.

1.2. THIS INSTALLATION GUIDE DOES NOT ATTEMPT TO ADDRESS SAFETY CONCERNS ASSOCIATED WITH PIPE INSTALLATION OR UNDERGROUND CONSTRUCTION IN GENERAL.

1.3. CORRUGATED PLASTIC PIPE DERIVES STRUCTURAL STABILITY FROM THE STRENGTH AND RELATIVE STIFFNESS OF THE EMBEDMENT MATERIAL. IT IS THE RESULTING SOIL–PIPE INTERACTION SYSTEM THAT DEFINES THE PERFORMANCE OF THE INSTALLED PIPE.

1.4. PIPE DEFLECTIONS, OR VERTICAL REDUCTIONS IN DIAMETER, ARE MINIMIZED BY PROPER BACKFILL SELECTION, APPROPRIATE CONSTRUCTION PRACTICES, AND INCREASED INSTALLATION INSPECTION ACTIVITIES.

1.5. PIPE COVER HEIGHT, GROUNDWATER, AND DESIGN LIVE LOADS MAY BE A FACTOR IN APPROPRIATE BACKFILL MATERIAL SELECTION AND COMPACTION LEVELS.

1.6. BACKFILL LIFT CONSTRUCTION AND COMPACTION METHODS MAY VARY WITH THE BACKFILL MATERIALS AVAILABLE.

1.7. THIS INSTALLATION GUIDE RELATES METHODS CONSISTENT WITH ASTM D2321, STANDARD PRACTICE FOR UNDERGROUND INSTALLATION OF THERMOPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY–FLOW APPLICATIONS, WITH NO CLAIMS TO BE A REPLACEMENT TO THE MORE EXHAUSTIVE ASTM STANDARD.

1.8. AASHTO REGULATED INSTALLATIONS SHALL BE IN ACCORDANCE WITH SECTION 30 OF THE AASHTO LRFD BRIDGE CONSTRUCTION SPECIFICATIONS.

1.9. THERE ARE MANY EFFECTIVE NON–STANDARD METHODS OF ACHIEVING A GOOD INSTALLATION WHICH ARE NOT MENTIONED HEREIN. CONSULT THE ABOVE–MENTIONED ASTM AND AASHTO STANDARDS FOR VARIOUS ALTERNATIVE METHODS.

2. PIPE INSPECTION HANDLING AND STORAGE

2.1. ONCE THE PIPE IS RECEIVED ON THE JOB SITE AND PRIOR TO FINAL ACCEPTANCE, AN INSPECTION SHALL BE PERFORMED TO ENSURE THE MATERIAL IS FREE FROM DAMAGE AND MEETS PROJECT SPECIFICATIONS.

2.2. PIPE IS PROPERLY LIFTED WITH A SLING FORMED FROM A NYLON STRAP WITH LOOPED ENDS. USING TWO EQUALLY SPACED LIFT POINTS FOR THE LARGER SIZES WILL PREVENT THE PIPE ENDS FROM STRIKING OBJECTS OR BEING DRAGGED ALONG THE GROUND.

2.3. STACKING PIPE ON LEVEL GROUND WILL HELP MAINTAIN THE MANUFACTURED SHAPE ALONG THE LENGTH OF THE PIPE, ENSURING THE PIPE LAYS FLAT AND STRAIGHT ON THE PIPE BEDDING WHEN INSTALLED.

3. TRENCH CONSTRUCTION

3.1. TRENCH WIDTH MUST BE SUFFICIENT FOR PROPER PLACEMENT AND COMPACTION OF THE EMBEDMENT MATERIAL USING STANDARD MEANS AND METHODS, ESPECIALLY HAUNCHING WHERE MANUAL RODDING OR MECHANICAL TAMPERS ARE USED TO ENSURE THE PIPE HAUNCH IS PROPERLY FILLED AND COMPACTED.

3.2. NARROWER TRENCH WIDTHS NORMALLY PROVIDE BETTER PIPE SUPPORT IF THE NATIVE SOILS FORMING THE TRENCH WALL ARE STABLE. MINIMUM TRENCH WIDTH TABLE SHOWS MINIMUM ALLOWABLE TRENCH WIDTHS NEEDED FOR PROPER EMBEDMENT.

3.3. IF THE NATIVE SOILS FORMING THE TRENCH WALL ARE UNSTABLE BUT CAN SUSTAIN A VERTICAL CUT, THE TRENCH WIDTH SHOULD BE INCREASED TO PROVIDE SPACE ON EACH SIDE OF THE PIPE EQUAL TO ONE–HALF ITS OUTSIDE DIAMETER; OTHERWISE, SPACE EQUIVALENT TO A FULL OUTSIDE DIAMETER SHOULD BE PROVIDED ON EACH SIDE OF THE PIPE.

3.4. EMBANKMENT INSTALLATIONS ARE TYPICALLY CONDUCTED IN THE SAME MANNER AS TRENCH INSTALLATIONS ONCE THE EMBANKMENT REACHES A HEIGHT CORRESPONDING TO ONE FOOT ABOVE THE TOP OF PIPE. THE TRENCH WIDTH IS THEN MANAGED AS IF CUT IN UNSTABLE NATIVE SOILS.

3.5. THE TRENCH BOTTOM SHOULD BE FIRM AND STABLE. RESTORE OR OTHERWISE REPLACE SOFT OR UNSTABLE MATERIAL WITH A MORE SUITABLE, STABLE MATERIAL. DISPLACE FOUNDATION MATERIAL WITH HEAVY, DENSE MATERIAL (E.G. COARSE GRAVEL OR CRUSHED ROCK) TO MITIGATE A "SOUPY" OR "QUICK" CONDITION.

3.6. ROCK OR UNYIELDING MATERIAL AT THE TRENCH BOTTOM SHOULD BE REMOVED AND REPLACED TO PROVIDE FOR AN ADDITIONAL TWO INCHES OF BEDDING MATERIAL BEYOND THE MINIMUM BEDDING THICKNESS.

3.7. SLOUGHED MATERIAL FROM THE TRENCH SIDEWALLS SHOULD BE REMOVED.

4. TRENCH BOX CONSTRUCTION

4.1. TRENCH WIDTH REQUIREMENTS CORRESPOND TO THE DISTANCE BETWEEN THE INTERIOR WALLS OF THE TRENCH BOX AND THEREFORE THE EXCAVATION WIDTH WILL INCREASE ACCORDINGLY.

4.2. DO NOT COMPACT EMBEDMENT MATERIAL AGAINST THE WALLS OF THE TRENCH BOX SO AS NOT TO DISTURB THE INSTALLED PIPE AND ITS EMBEDMENT WHEN MOVING THE TRENCH BOX.

4.3. PROPER PLACEMENT AND COMPACTION OF THE SIDEFILL IS DONE BELOW THE BOTTOM EDGE OF THE TRENCH BOX AS IT IS RAISED VERTICALLY IN APPROXIMATE 12–INCH INCREMENTS, REMOVING ANY SLOUGHED MATERIAL AS THE PROCESS CONTINUES.

4.4. THE PRACTICE OF USING A SUB–TRENCH WILL MITIGATE THE CHALLENGES ASSOCIATED WITH HAUNCH AND SIDEFILL PLACEMENT AND COMPACTION. WHERE SUB–TRENCHES ARE NOT ALLOWED THE TRENCH BOX SHOULD BE WIDENED TO MITIGATE THE CHALLENGES.

4.5. USING MANUFACTURED AGGREGATES THAT REQUIRE LITTLE COMPACTIVE EFFORT WILL PRODUCE THE BEST RESULTS FOR TRENCH BOX INSTALLATIONS.

5. BEDDING

5.1. THE BEDDING MUST ENSURE UNIFORM PIPE SUPPORT TO THE DESIGN LINE AND GRADE, WITH THE MIDDLE–THIRD BENEATH THE PIPE OD LEFT LOOSE TO CRADLE THE PIPE AND MITIGATE THE EFFECTS OF POOR HAUNCHING.

5.2. THE BEDDING MATERIAL IS TYPICALLY THE SAME MATERIAL USED FOR PIPE EMBEDMENT, IDEALLY A CLEAN, COHESIONLESS, FREE–DRAINING SOIL WITH PARTICLES THAT MOVE AROUND EASILY IN ORDER TO CONFORM TO THE SHAPE OF THE PIPE BOTTOM.

6. HAUNCHING

6.1. HAUNCH FILLING IS CARRIED OUT ON BOTH SIDES SIMULTANEOUSLY TO AVOID ROLLING THE PIPE. GENTLY DUMPING SMALL AMOUNTS OF MATERIAL ON TOP OF THE PIPE WILL PROVIDE SOME STABILITY WHILE MATERIAL FALLING BESIDE THE PIPE CAN BE PUSHED INTO THE HAUNCH ZONE.

6.2. FILLING ADJACENT SIDEFILL ZONES WILL PROVIDE LATERAL SUPPORT TO THE HAUNCH MATERIAL DURING THE PROCESS. LOOSE LAYERS IN FOUR TO SIX–INCH LIFTS WILL PERMIT THE BACKFILL MATERIAL TO BE WORKED INTO THE HAUNCH ZONE.

6.3. MATERIAL SHOULD BE MANUALLY PLACED IN THE HAUNCHES. TECHNIQUES SUCH AS RODDING, KNIFING, OR SHOVEL SLICING ARE EFFECTIVE TO ENSURE THE HAUNCH IS FILLED.

6.4. MECHANICAL TAMPERS, MANUAL TAMPERS, OR OTHER MEANS THAT FILL VOIDS AND MEET SPECIFIED COMPACTION LEVELS MUST BE USED CAREFULLY. CONTROLLING THE COMPACTION FORCE WILL PREVENT THE PIPE FROM LIFTING OFF GRADE. DO NOT PERMIT COMPACTION EQUIPMENT TO CONTACT THE PIPE.

7. LIFT THICKNESS AND COMPACTION

7.1. LIFT THICKNESS AND COMPACTION MUST BE DONE EVENLY ON EACH SIDE OF THE PIPE. THE MAXIMUM DIFFERENCE IN THE SIDEFILL ELEVATIONS AT ANY GIVEN TIME IS GENERALLY LIMITED TO ONE LIFT THICKNESS.

7.2. WHILE SIX–INCH LIFTS ARE COMMONLY SPECIFIED, 12–INCH LIFTS CAN PRODUCE GOOD RESULTS WITH COARSE–GRAINED BACKFILLS PROVIDED PLACEMENT AND COMPACTION PRACTICES ARE APPROPRIATE.

7.3. USE COMPACTION EQUIPMENT AND TECHNIQUES THAT ARE COMPATIBLE WITH THE MATERIALS USED AND LOCATION IN THE TRENCH. MECHANICAL TAMPERS WILL BE MORE EFFICIENT IN TRENCH BOX CONDITIONS, OTHERWISE WALK–BEHIND VIBRATORY COMPACTORS ARE TYPICALLY USED.

7.4. COMPACTION EFFICIENCY IS ACHIEVED BY ESTABLISHING THE NUMBER OF PASSES THAT PRODUCES THE DESIRED DENSITY. IF THE SPECIFIED DENSITY IS 95% OF MAXIMUM STANDARD PROCTOR DENSITY, THEN GOOD PIPE PERFORMANCE WILL RESULT EVEN IF THE COMPACTION IS SLIGHTLY LESS THAN SPECIFIED.

7.5. AN ADDITIONAL SIX INCHES OF STRUCTURAL BACKFILL OVER THE TOP OF THE PIPE PROVIDES A COMPLETE ENVELOPE THAT BETTER LOCKS UNDERLYING MATERIAL TOGETHER AND PROTECTS THE PIPE FROM ANY DAMAGING IMPACTS FROM THE FINAL BACKFILL.

8. FINAL BACKFILL

8.1. FINAL BACKFILL DOES NOT DIRECTLY SUPPORT THE PIPE AND IS MORE APPROPRIATELY DEALT WITH IN CONNECTION WITH THE INTENDED USE AT THE SURFACE. SELECTION, PLACEMENT AND COMPACTION OF FINAL BACKFILL IS THEREFORE DIRECTED BY THE DESIGN ENGINEER. HOWEVER, WHEN FINAL BACKFILL CONTAINS LARGE FRAGMENTS OR COBBLES, THE INITIAL BACKFILL COVER LEVELS MAY NEED TO BE INCREASED ACCORDINGLY TO PROTECT THE PIPE FROM ANY POTENTIAL IMPACT OR POINT LOADING.

9. EMBEDMENT MATERIALS & ASTM D2321 SOIL CLASSIFICATIONS

9.1. GOOD PIPE PERFORMANCE IS MORE LIKELY REALIZED WHEN THE BACKFILL MATERIALS ARE LIMITED TO WELL–GRADED, COARSE–GRAINED SOILS (SANDS AND GRAVELS) WITH LESS THAN 12% FINES, OR UNIFORMLY SIZED COARSE–GRAINED SOILS (GRAVELS) WHEN SOIL MIGRATION INTO THE VOIDS IS EITHER UNLIKELY OR ADDRESSED. UNIFORM FINE SANDS SHOULD BE AVOIDED. COARSE–GRAINED SOILS WITH FINES OR FINE–GRAINED SOILS WITH AT LEAST 30% COARSE–GRAINED MATERIAL PROVIDE GOOD PERFORMANCE IF PLACED AND COMPACTED PROPERLY, BUT INCREASED INSPECTION DURING INSTALLATION IS RECOMMENDED. BACKFILL SHOULD BE COMPACTED TO AT LEAST 95% OF MAXIMUM STANDARD PROCTOR DENSITY FOR APPLICATIONS IN ROADWAYS.

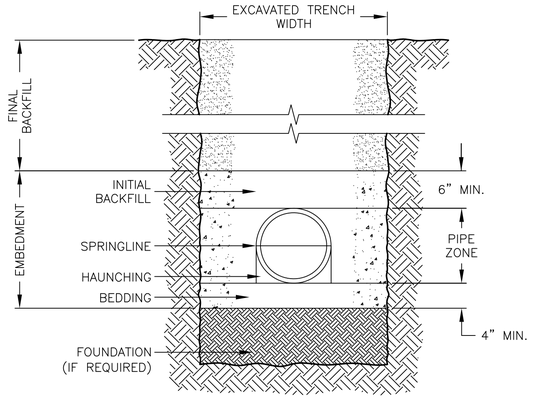
9.2. ASTM D2321 SOIL CLASSIFICATIONS ARE GROUPED BY TYPICAL SOIL STIFFNESS (I.E. STRENGTH) WHEN COMPACTED. CLASS I INDICATES A MATERIAL THAT GENERALLY PROVIDES THE HIGHEST STIFFNESS AT ANY GIVEN PERCENT COMPACTION, AND PROVIDES A GIVEN STIFFNESS WITH THE LEAST COMPACTIVE EFFORT. EACH HIGHER NUMBER SOIL CLASS PROVIDES SUCCESSIVELY LESS STIFFNESS AT A GIVEN PERCENT COMPACTION AND REQUIRES GREATER COMPACTIVE EFFORT TO PROVIDE A GIVEN LEVEL OF SOIL STIFFNESS.

9.3. USING THE STIFFER EMBEDMENT MATERIALS (ESP. CLASSES I AND II) IS KEY TO MINIMIZING PIPE DEFLECTION AND THE NEED FOR DETAILED INSTALLATION INSPECTION AND COMPACTION TESTING. FOR THESE REASONS ONLY SOIL CLASSIFICATIONS I, II AND III ARE PRESENTED HERE. CLASS IV MATERIALS REQUIRE A GEOTECHNICAL EVALUATION PRIOR TO USE AND MAY NOT BE SUITABLE FOR DEEP FILL OR SHALLOW COVER APPLICATIONS. CLASS V MATERIALS ARE NOT ALLOWED IN THE PIPE–ZONE EMBEDMENT.

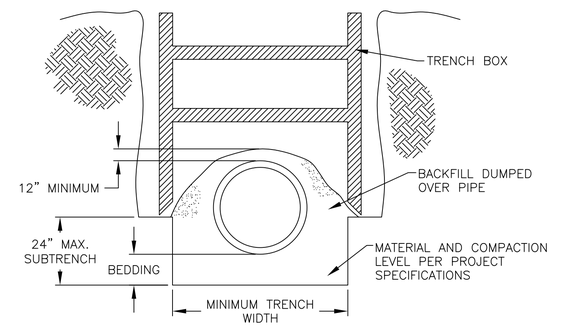
9.4. CLASS I MATERIALS PROVIDE MAXIMUM STABILITY AND PIPE SUPPORT FOR A GIVEN PERCENT COMPACTION. WITH MINIMUM EFFORT, THESE MATERIALS CAN BE INSTALLED AT RELATIVELY HIGH STIFFNESSES. SUITABLE COMPACTION IS TYPICALLY ACHIEVED WITH A DUMPED PLACEMENT PROVIDED MATERIAL IS WORKED INTO THE HAUNCH ZONE. VIBRATION OR IMPACT COMPACTION METHODS WILL ENSURE THE HIGHEST LEVELS OF STIFFNESS FOR THE DEEPER FILLS.

9.5. CLASS II MATERIALS PROVIDE A RELATIVELY HIGH LEVEL OF PIPE SUPPORT WHEN MODERATELY COMPACTED WITH EITHER VIBRATION OR IMPACT COMPACTION METHODS.

9.6. CLASS III MATERIALS PROVIDE LESS SUPPORT FOR A GIVEN PERCENT COMPACTION THAN CLASS I OR CLASS II MATERIALS. HIGHER LEVELS OF COMPACTIVE EFFORT ARE REQUIRED AND MOISTURE CONTENT MUST BE NEAR OPTIMUM TO MINIMIZE COMPACTIVE EFFORT AND ACHIEVE THE REQUIRED PERCENT COMPACTION. THESE MATERIALS PROVIDE REASONABLE LEVELS OF PIPE SUPPORT ONCE PROPER PERCENT COMPACTION IS ACHIEVED.



TYPICAL TRENCH DETAIL



SHORED TRENCH DETAIL

LANE HD 100/PRO 100 – ALLOWABLE BURIED DEPTHS (FT)						
DIAMETER	CLASS I		CLASS II		CLASS III	
(in)	COMPACTED	DUMPED	95%	90%	95%	90%
12	29/39	21/30	21/31	15/23	15/23	10/12
15	26/30	23/28	19/23	13/17	14/18	10/11
18	29/30	22/23	21/23	15/16	15/17	10/11
24	27/30	21/23	20/23	14/16	14/16	9/11
30	25/27	19/20	18/20	12/14	13/14	9/10
36	27/29	22/22	20/21	13/15	14/16	9/10
42	33/	23/	22/	15/	15/	10/
48	23/25	17/19	16/18	10/12	11/13	7/9
60	25/25	19/19	18/18	12/12	12/13	7/8

1. INSTALLATION IN ACCORDANCE WITH ASTM D2321
2. CLASS I INDICATES A SOIL THAT GENERALLY PROVIDES THE HIGHEST SOIL STIFFNESS AT ANY GIVEN PERCENT COMPACTION, AND PROVIDES A GIVEN SOIL STIFFNESS WITH THE LEAST COMPACTIVE EFFORT. EACH HIGHER NUMBER SOIL CLASS PROVIDES SUCCESSIVELY LESS SOIL STIFFNESS AT A GIVEN COMPACTION AND REQUIRES GREATER COMPACTIVE EFFORT TO PROVIDE A GIVEN LEVEL OF SOIL STIFFNESS.
3. ALL ACCEPTABLE BACKFILL MATERIALS ARE NOT PRESENTED HERE. SEE ASTM D2321 FOR A COMPLETE LISTING OF CLASSIFICATIONS.
4. RESULTS BASED ON AASHTO LRFD DESIGN METHOD USING ZERO HYDROSTATIC PRESSURE AND A SOIL DENSITY OF 120 PCF. GREATER COVER HEIGHTS ARE ATTAINABLE WITH APPROPRIATE MODIFICATIONS TO THE DESIGN METHOD – CONTACT LANE FOR FURTHER DETAILS.
5. DUMPED CLASS I MATERIAL IS ESTIMATED AT 90% MAXIMUM STANDARD PROCTOR DENSITY.

MINIMUM COVER HEIGHTS FOR LIVE LOADS		
PIPE DIAMETER	LOADING[1]	MIN. COVER
6"–48"	H20,H25 OR HL93	12"
60"	H20,H25 OR HL93	24"

NOTES: 1. MAY BE SUBJECT TO LOCAL AGENCY MINIMUM COVER REQUIREMENTS.

TEMPORARY MIN. COVER FOR CONSTRUCTION LOADS				
NOMINAL PIPE DIAMETER (FT)	MINIMUM COVER (IN) FOR INDICATED AXLE LOADS (KIPS)			
	18–50	50–75	75–110	110–150
2.0–3.0	2.0	2.5	3.0	3.0
3.5–5.0	3.0	3.0	3.5	4.0
MINIMUM COVER SHALL BE MEASURED FROM TOP OF PIPE TO THE TOP OF THE MAINTAINED CONSTRUCTION ROADWAY SURFACE.				

BACKFILL CLASSIFICATION TABLE			
ASTM D2321 SOIL CLASS	GENERAL SOIL DESCRIPTION	ASTM D2321 SOIL GROUP	AASHTO M145 SOIL GROUP
CLASS I[1]	MANUFACTURED AGGREGATE	CRUSHED ROCK WITH ANGULAR, FRACTURED PARTICLE FACES AND 100% PASSING THE 1½" SIEVE 15% OR LESS PASSING THE #4 SIEVE 25% OR LESS PASSING THE ⅜" SIEVE 12" OR LESS PASSING THE #200 SIEVE	
CLASS II	CLEAN, COURSE GRAINED SOILS	SAND AND GRAVELS WITH 12% OR LESS PASSING #200 SIEVE. ASTM D2487 SOIL GROUP: GW WELL–GRADED GRAVELS AND GRAVEL–SAND MIXTURES GP POORLY GRADED GRAVELS AND GRAVEL–SAND MIXTURES SW WELL–GRADED SANDS AND GRAVELLY SANDS SP POORLY–GRADED SANDS AND GRAVELLY SANDS	A1, A3
CLASS III	COARSE GRAINED SOILS AND FINES	COARSE GRAINED SOILS WITH MORE THAN 12% PASSING #200 SIEVE. ASTM D2487 SOIL GROUP: GM SILTY GRAVELS, GRAVEL–SAND–SILT MIXTURES GC CLAYEY GRAVELS, GRAVEL–SAND–CLAY MIXTURES SM SILTY SANDS, SAND SILT MIXTURES	A–2–4, A–2–5, A–2–6 OR A–4
CLASS IV	SANDY OR GRAVELLY FINE–GRAINED SOILS	SANDY OR GRAVELLY FINE–GRAINED SOILS WITH 30% MORE RETAINED ON #200 SIEVE. ASTM D2487 SOIL GROUP: CL GRAVELLY CLAYS, SANDY CLAYS ML SILTY OR CLAYEY FINE SANDS	A–6

NOTES: 1. OPEN GRADED, HIGH PERMEABILITY AASHTO NO. 57 COMMONLY USED.

THE USE OF A TRENCH BOX FOR THE DEEPER INSTALLATIONS TYPICALLY CHALLENGES THE ABILITY TO MAINTAIN SIDE FILL SUPPORT AS THE TRENCH BOX IS ADVANCED. VOIDS LEFT BY THE TRENCH BOX WALLS, AS WELL AS THE VOID LEFT BETWEEN THE TRENCH BOX AND THE EXCAVATION AND/OR DISTURBED MATERIAL SLOUGHING AGAINST THE OUTSIDE OF THE TRENCH BOX SHALL BE ADDRESSED TO ENSURE COMPACTED SUPPORT EXTENDING TO UNDISTURBED NATIVE MATERIALS. THE PRACTICE OF USING A SUB–TRENCH MITIGATES THE CHALLENGES ASSOCIATED WITH TRENCH BOX CONSTRUCTION.

MINIMUM TRENCH WIDTH (T_{MIN}) PER ASTM D2321 FOR STABLE TRENCH WALLS					
ID (in)	OD (in)	T_{MIN} (in)	ID (in)	OD (in)	T_{MIN} (in)
6	7.05	24	24	28	47
8	9.4	26	30	34.5	56
10	12	28	36	41	64
12	14.5	31	42	47.5	72
15	17.5	34	48	57.5	81
18	21.5	39	60	66.9	96

MULTIPLE PIPE RUNS

INSTALLATION METHODS FOR MULTIPLE RUNS OF PIPE SHALL BE CONSISTENT WITH TRENCH AND EMBANKMENT INSTALLATIONS WITH THE ADDED CONDITION THAT BACKFILLING PROGRESS EVENLY ACROSS ALL PIPE RUNS. SPACING BETWEEN PIPES SHALL BE SUFFICIENT TO PERMIT THE PROPER PLACEMENT AND COMPACTION OF STRUCTURAL BACKFILL IN THE HAUNCH AND BETWEEN THE STRUCTURES. AS A GUIDE, AASHTO INDICATES THE MINIMUM SPACING BETWEEN PIPES SHOULD NOT BE LESS THAN THAT SHOWN IN THE TABLE BELOW:

PIPE DIAMETER	MINIMUM SPACING
UP TO 24"	12"
24"–60"	½"D
SPACING SHALL BE BETWEEN THE OUTSIDE DIAMETER (OD) OF THE PIPE	

LANE

NO	BY	DATE	REMARKS

HD100, HD100EC & PRO100 TRENCH INSTALLATION NOTES AND DETAILS

SCALE: NTS
DRAWN BY: JDS
DATE: 2/8/2021
PROJECT NUMBER:
SHEET: 1 OF 1