Section 575

Wastewater Lift Stations

PART 1: General

1.1 *Overall Design* – All lift station components, including fiberglass wetwell, shall be designed (signed and sealed) by a Florida Professional Engineer.

1.2 *Purpose* – Lift stations shall be provided at any point in a proposed sewage collection system where the upstream gravity collection system cannot be physically connected to the existing collection system in a manner to permit gravity flow. System extensions shall be designed to avoid lift stations as much as possible.

1.2.1 In general, lift stations may lift flows to a higher elevation, transport flow horizontally or combine lifting and horizontal transport.

1.2.2 In general, lift stations shall utilize submersible pumps placed in a below-ground wet well, unless otherwise noted.

1.3 *Oversizing* – Lift stations often offer oversizing opportunities due to ECUA system growth patterns and the need to accommodate such growth with efficient planning and design of proposed stations. Oversizing options for lift stations include but are not limited to parcel size, pumping rate, wetwell size, force main size, etc. All oversizing decisions should be made by ECUA during the design process in accordance with Procedure 6 – Oversizing, and shall be documented in the Utility Service Agreement for the applicable project.

1.4 *Future Need* – When the wet well and force main are oversized for future requirements, the station piping, electrical service, and controls shall be sized accordingly. When it is anticipated that a third pump is to be installed in the future, the station shall be designed to accommodate through-wall piping in the wet well top, a manifold into the discharge force main, and appropriate equipment in the control panel.

1.5 *Location and Design* – Lift station location and design capacity shall be compatible with the ECUA Collection System Master Plan. Lift stations shall be designed to operate effectively at initial flows as well as at ultimate design flows. To that end, each lift station design must address several interrelated elements including, but not limited to:

1.5.1 Wet well size (diameter and depth)

1.5.2 Force main size and lift station piping

1.5.3 Pump and control selection

1.5.4 Flow quantity and lift station appurtenances

1.6 *Calculations* – Lift station calculations shall be performed, signed, and sealed by a Florida Professional Engineer, and shall be done in accordance with this procedure and the rest of the ECUA Engineering Manual, as well as include design considerations and variables as offered by ECUA staff.

1.7 *Lift Station Pump Overview Chart* – The Engineer-of-Record (EOR) shall review ECUA's Lift Station Pump Overview Chart and all applicable sections of the ECUA Engineering Manual prior to initiating design.

1.8 *Lift Station Manufacturer's Contact List* – ECUA has compiled a list of ECUA approved lift station component manufacturers, along with contact information. This information is contained in ECUA's Lift Station Approved Manufacturers and Sales Contacts List.

1.9 *Pump Selection Worksheet* – Once the initial pump coordination with ECUA has been completed, the system design has been performed, and the pump requirements have been determined, the EOR shall contact each of ECUA's approved pump manufacturers and request them submit their best pump for the application. The EOR shall then utilize ECUA's Pump Selection Worksheet in order to determine a group of pumps that are acceptable to the ECUA. In determining the appropriate group of pumps, the EOR shall analyze the technical, performance, efficiency, cost, future flow capacity, future head capacity, future impeller upgrades and other related data such that the selected pumps are deemed equivalent to each other within the group and as a group better suited to the project application than non-selected pumps. The EOR should strive to create a manageable list of at least two acceptable pumps, preferably three. Said document shall be signed by the EOR, ECUA Project Engineer, and ECUA Lift Station Representative thus certifying the pumps on the worksheet are acceptable for use on project. Said pump selection information shall then be recorded in the pump chart on the lift station detail sheet thus making any of the pumps available for use on the project.

PART 2: Design Criteria

2.1 *Lift Station Siting* – Lift station shall be located to allow sewage collection by means of gravity flow from the largest feasible drainage area. Consideration may be given to locating lift stations to permit continuing future downstream gravity sewer system development where possible and consistent with ECUA's Collection System Master Plan.

2.1.1 *General Location* – Lift station wetwell top elevation shall be at least three feet above the 100 year flood level as designated by FEMA Flood Maps, and at least three feet above the highest berm elevation of any nearby stormwater pond. In no case should the lift station be placed in an area subject to prolonged periods of flooding. Wetwell shall be higher than surrounding area to prevent over-wash of station. The parcel and any associated access driveways shall be designed to permit proper drainage away from the lift station.

2.1.2 *Access* – Lift station parcels shall be located to provide sufficient accessibility for maintenance vehicles at all times. Accessibility includes, but is not limited to, adequate space for ECUA service vehicles to perform turn-around maneuvers if needed, gate access, etc. Parcels shall be located adjacent to roadway right-of-way as much as possible. Parcels not adjacent to roadway right-of-way shall be provided with a 20 foot wide access parcel that connects the lift station parcel to the roadway right-of-way. Driveways shall be 12 feet wide minimum (may be wider per ECUA access needs) and may be either paved (2-inch asphalt, 6-inch graded aggregate base, 12-inch sub-grade stabilization) or rock surface (8-inch graded aggregate base, 12-inch sub-grade stabilization) capable of supporting H-20 traffic loading.

2.1.3 *Parcel Requirements* – The lift station parcel shall be 50 feet in width and 50 feet in depth. Any reduction will require written justification from the EOR and written approval of the

Director of Engineering and the Director of Maintenance. Depending on the lift station and its needs, parcels larger than 50 feet x 50 feet may be required if necessary to accommodate additional equipment or access. Title to the lift station site, access drive, and easements shall be conveyed to ECUA in accordance with ECUA policy. The site shall be fenced in accordance with the plans unless specifically exempted.. Access driveways shall not be shared with private entities, such as home owners or homeowner associations.

2.1.4 *Electrical Service* – The lift station site shall have access to three phase power (minimum ECA requirement) installed in accordance with Gulf Power and the station's voltage needs.

2.2 *Design Criteria* –

2.2.1 *Redundancy* – Lift stations shall contain a minimum of 2 pumps. Additional pumps may be required based on coordination with ECUA.

2.2.2 *Minimum Pumping Rate* – The Average Daily Flow for lift station collection areas shall be developed in accordance with Section 570-"Gravity Sewer Collection Systems". Peak hourly flow (PHF) shall be determined using the *Ten States Standards* peaking formula. The minimum PHF for each pump shall be 125 gallons per minute (GPM). On ECUA Capital Improvement Projects (CIP), ECUA will typically select 250 GPM as the minimum PHF for each pump. On System Extension Projects (aka Developer), ECUA may elect to increase design pumping rates based on future system needs and cost effectiveness, via ECUA cost sharing and oversizing program.

2.2.3 *System Head* – Calculate system heads based on pumping rates above. Include minimum, average, and maximum static head conditions to insure pump selection can perform adequately for each head condition.

2.2.4 *Pump Curves with System Head Curves* - Submit factory pump curves showing efficiencies, horsepower, and all available impellor sizes, superimposed with system head curves generated by EOR. **Excel generated curves will not be allowed.**

2.2.5 *Velocities* – The lift station discharge force main (riser piping) minimum velocity shall be 2.5 fps, although 5 fps is preferred, and in no case shall it exceed 10 fps. If flow monitoring is required, the riser piping velocity shall be maintained through the flow meter. The force main velocity in the remaining parts of the proposed transmission system (downstream of the above-grade plug valves or flow meter) shall not be less than 2.5 fps.

2.2.6 *Pump Efficiencies* – Pump efficiency is just one of the criteria used in determining the list of acceptable pumps for each station. Smaller stations by nature are not as efficient as larger stations, therefore it is un-realistic for ECUA to set high goals for minimum efficiencies of said small stations. For small stations, the EOR shall balance efficiencies with other functional criteria as part of the analysis and selection of acceptable pumps. For larger lift stations, as determined by ECUA, or those stations that are anticipated to have a total daily runtime greater than 5 hours, the EOR shall utilize either a minimum efficiency approach or specify pumps that operate at a certain percentage of BEP as part of the analysis and selection of allowable pumps.

2.2.7 *Downstream Impacts* – The EOR shall coordinate with ECUA Engineering staff to analyze downstream capacities. ECUA staff will assist the EOR to the extent possible with the analyses noted below.

2.2.7.1 When the force main will manifold into an existing force main, the impact on that line and all existing lift stations that utilize that line must be evaluated by the EOR and ECUA staff.

2.2.7.2 When the force main could either discharge to an existing lift station or manifold into that station's force main, an analysis shall be made to determine which alternative is in the best long-term interest of ECUA.

2.2.8 *Wet Well Sizing* – The minimum wet well size shall be 8-feet in diameter. The wet well shall be sized by determining the combination of diameter and depth most suitable to handle the intended maximum design capacity with adequate provision for emergency storage.

2.2.8.1 *Anti-flotation* – Anti-flotation design shall incorporate the following:

2.2.8.1.1 Wet well empty weight and soil pressure on concrete base collar may be used to calculate down forces, but pump and piping weights shall not be used. Assume groundwater is at grade. A factor of safety of 1.2, minimum, must be used in anti-flotation calculations.

2.2.8.1.2 Delegated Engineer shall design anti-floatation base as part of Delegated Engineering Documents requirements with minimum sizing per ECUA Design Standard Drawings.

2.2.8.2 *Liquid Level Control Elevations* – See Appendix for design guidance requirements.

2.2.8.3 *Concrete Cover* – Delegate Engineer shall design concrete cover as part of Delegated Engineering Documents requirements with minimum sizing per ECUA Design Standard Drawings.

2.2.8.4 *Pump Mounting Baseplate* – Delegate Engineer shall design pump mounting baseplate as part of Delegated Engineering Documents requirements with minimum sizing per ECUA Design Standard Drawings.

2.2.8.5 *Design Submittal* – Delegate Engineer shall submit wetwell design as part of the Delegated Engineering Documents for ECUA's review and approval.

2.2.9 *Antenna Height* – A radio path study will be provided by ECUA on CIP and System Extension projects. The study will determine the appropriate antenna height for the EOR's use in the design plans. Once the proposed lift station site location has been confirmed by ECUA, the EOR shall then request the radio path study to be performed by ECUA. The ECUA Project Engineer shall forward results of study as they become available.

2.2.10 *Fencing* – Fencing shall be designed in accordance with ECUA specification Section 2830 and Lift Station Design Standard Drawings, unless specifically waived by ECUA's Engineer.

2.2.10.1 The Gulf Power service meter location shall be designed to be outside the fence or located in order to be read without entering the fence.

2.2.10.2 On all ECUA lift stations, gate shall be 14’ wide aluminum cantilever slide gate. On System Extension Projects (AKA Developer), ECUA shall pay the incremental cost increase between a rolling gate and a cantilever slide gate, via ECUA cost sharing and oversizing program.

2.2.11 *Bypass Pumping* – Emergency bypass (aka pump-out) piping with plug valve and quick-connect coupling shall be the same size (up to 8-inch diameter) as the station piping, and shall be designed and located per ECUA's Lift Station Design Standard Drawings. Additionally, for stations with long driveways, an underground pump-out connection shall be designed and located in the connecting road ROW per ECUA’s Lift Station Design Standard Drawings.

2.2.12 *Emergency Power* – Standby emergency power will be required as follows:

2.2.12.1 At a minimum, ECUA lift stations shall be designed with a manual transfer switch for connecting a portable generator, unless one of the options below is incorporated.

2.2.12.2 Some lift stations shall be designed with an automatic transfer switch (ATS) for connecting to either a permanent generator or portable generator dedicated to the site. EOR shall coordinate with ECUA on the location and type of switch required for each station.

2.2.12.3 Lift stations that discharge through a 12-inch diameter or larger piping shall require an on-site emergency generator suitably located and wired for automatic transfer. Generator will be of sufficient size to run all of the station equipment. For duplex lift stations, the generator must be sized to run two pumps at a time. For triplex lift stations, the generator must be sized to run the remaining pump(s) with the largest pump out of service.

2.2.13 *Flow Measurement* – Flow measuring devices shall be provided with lift stations that have a design flow of 1,200 gpm or greater (per FDEP) or as required by ECUA. Flow measurement device shall have instantaneous, totalizing, and recording capabilities.

2.2.14 *Mixers/Chemical Feed Equipment* – Mixers and/or chemical feed equipment may be required at lift stations or elsewhere in the collection system if hydrogen sulfide and other gases create problems. If chemical feed equipment is not required initially, access must be provided for possible future use.

APPENDIX

Lift Station Design Reference Data

FORCE MAIN FLOWS (GPM)

Velocity (fps)	Force Main Diameter										
	2"	3"	4"	6"	8"	10"	12"	14"	16"	20"	24"
2	20	40	80	180	310	490	700	960	1250	1960	2820
2.5	25	60	100	220	390	610	880	1200	1570	2450	3520
3	30	70	120	260	470	730	1060	1440	1880	2940	4230
4	40	90	160	350	630	980	1410	1920	2510	3910	5640
5	50	110	200	440	780	1220	1760	2400	3130	4890	7050
6	60	130	230	530	940	1470	2110	2880	3760	5870	8460
7	70	150	270	620	1100	1710	2470	3360	4380	6850	9860
8	80	180	310	700	1250	1960	2820	3840	5010	7830	11270
9	90	200	350	790	1410	2200	3170	4320	5640	8810	12680
10	100	220	390	880	1570	2450	3520	4800	6260	9790	14090

PIPE VOLUMES (Gal/100 FT):

Diam.	2"	3"	4"	6"	8"	10"	12"	14"	16"	20"	24"	36"
Vol.	19	42	70	153	259	405	573	800	1044	1632	2350	5284

VOLUMES PER VERTICAL FOOT (Gal)

	Manholes			Wetwells			
Diameter	4’	5’	6’	8’	10’	12’	14’
Volume	94	147	211	376	587	846	1151

STANDARD MOTOR SIZES, FULL LOAD AMPS, AND STARTER TYPE SELECTION

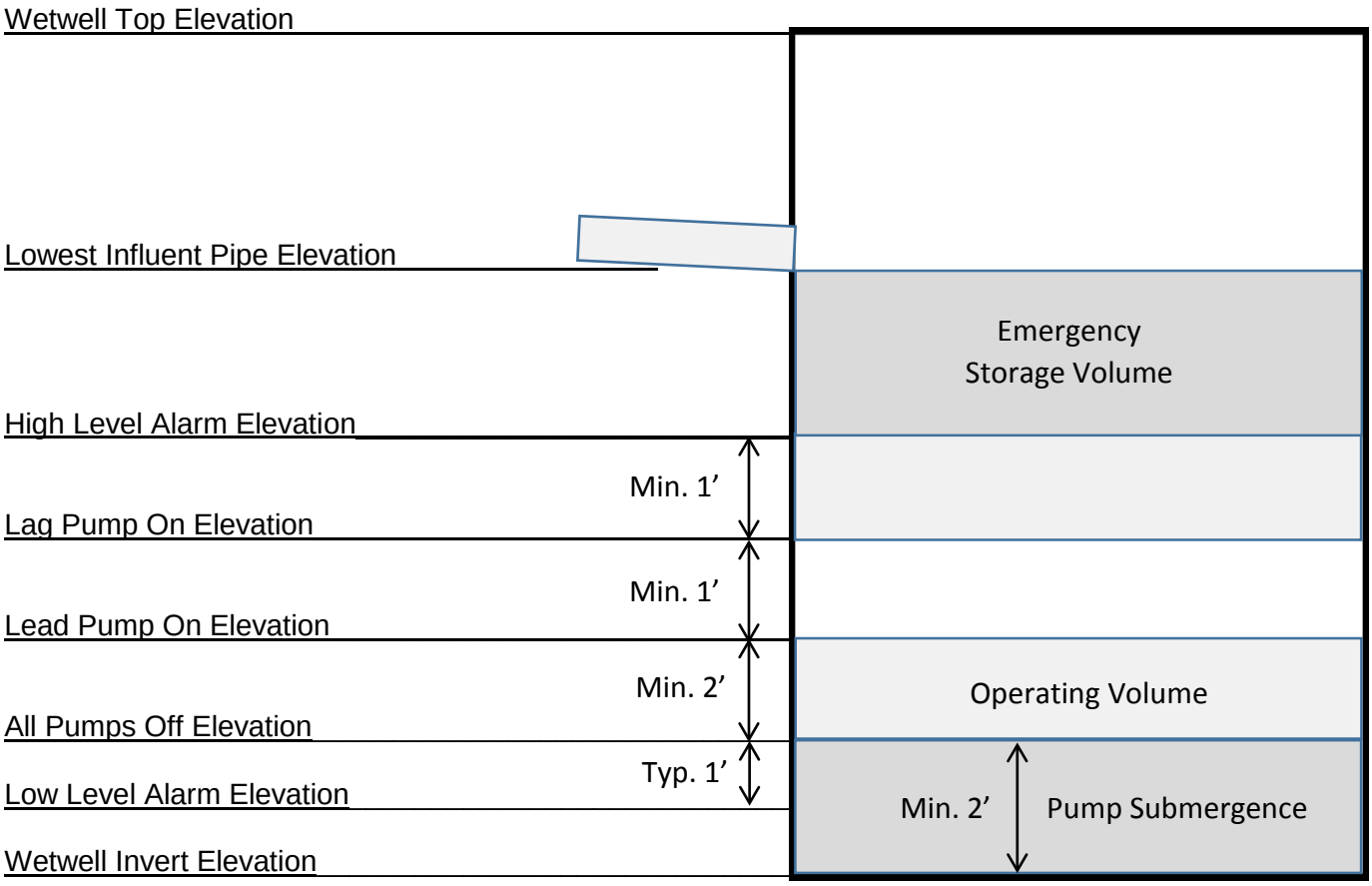
(Data below is for reference purposes only. EOR shall use pump supplier motor sizes, FLA ratings, and then consult with ECUA on motor starter selection.)

Motor Size (HP)	Typical Full Load Amps		Typical Motor Starter Selection
	230 V	460 V	
5	15.2	7.6	FVNR(ATL)
7.5	22	11	FVNR(ATL)
10	28	14	FVNR(ATL)
15	42	21	FVNR(ATL)
20	54	27	RVSS (Soft start), or VFD
25	68	34	RVSS (Soft start), or VFD
30	80	40	RVSS (Soft start), or VFD
40	104	52	RVSS (Soft start), or VFD
50	130	65	VFD
60	154	77	VFD
75	192	96	VFD
100	248	124	VFD

Wetwell Sizing and Liquid Level Control Elevation Guidelines

The following elevations and volumes shall be included in the EOR's design calcs and plans:

a. **Wetwell Top Elevation:** Use elevation per site plan design.
b. **Lowest Influent Pipe Elevation:** Use elevation per collection system design.
c. **Emergency Storage Volume:** Calculate volume based on 30 minutes of average daily flow, determine height of volume based on wetwell diameter.
d. **High Level Alarm Elevation:** Set elevation per bottom of emergency storage volume calcs.
e. **Lag Pump On Elevation:** Set elevation minimum 1' below high level alarm elevation.
f. **Lead Pump On Elevation:** Set elevation minimum 1' below lag pump on elevation.
g. **Operating Volume:** Calculate operating volume: $V_{[gal]} = t\ Q\ /\ 4$, where t (pump cycle time) = 10 minutes and Q = pumping rate (gpm). Determine height of volume based on wetwell diameter. Minimum height shall be 2'.
h. **All Pumps Off Elevation:** Set elevation per bottom of operating volume calcs.
i. **Low Level Alarm Elevation:** Set elevation one foot below the all pumps off elevation.
j. Minimum Pump Submergence: Shall be the greater of either 2' depth or depth as dictated by pump manufacturer.
k. **Wetwell Invert Elevation:** Set elevation based on selected minimum pump submergence and all pumps off elevation.



Friction Loss per 100 Feet Length of Pipe. Hazen-Williams "C"=140. Pipe Sizes in Inches.

(Multiply friction losses below by the corresponding multipliers for "C" Factors other than 140: ("C"…multiplier): 100…1.86, 110…1.56, 120…1.33, 130…1.15)

Flowrate (gpm)	1/2 -inch		3/4 -inch		1 -inch		1 1/4 -inch		1 1/2 -inch		2 -inch		2 1/2 -inch		3 -inch		4 -inch		5 -inch		6 -inch	
	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)	Veloc. (fps)	Loss (ft)
2	2.11	4.07	1.20	1.03	0.74	0.32	0.43	0.08	0.32	0.04	0.19	0.01	0.13	0.00	0.09	0.00	0.05	0.00	0.03	0.00	0.02	0.00
4	4.23	14.69	2.41	3.73	1.49	1.15	0.86	0.30	0.63	0.14	0.38	0.04	0.27	0.02	0.17	0.01	0.10	0.00	0.06	0.00	0.04	0.00
6	6.34	31.13	3.61	7.91	2.23	2.44	1.29	0.64	0.95	0.30	0.57	0.09	0.40	0.04	0.26	0.01	0.15	0.00	0.10	0.00	0.07	0.00
8	8.46	53.04	4.82	13.48	2.97	4.16	1.72	1.10	1.26	0.52	0.77	0.15	0.54	0.06	0.35	0.02	0.20	0.01	0.13	0.00	0.09	0.00
10	10.57	80.18	6.02	20.38	3.71	6.29	2.15	1.66	1.58	0.78	0.96	0.23	0.67	0.10	0.43	0.03	0.25	0.01	0.16	0.00	0.11	0.00
12	12.69	112.38	7.22	28.56	4.46	8.82	2.58	2.32	1.89	1.10	1.15	0.33	0.80	0.14	0.52	0.05	0.30	0.01	0.19	0.00	0.13	0.00
15	15.86	169.89	9.03	43.18	5.57	13.34	3.22	3.51	2.37	1.66	1.44	0.49	1.01	0.21	0.65	0.07	0.38	0.02	0.24	0.01	0.17	0.00
18	19.03	238.13	10.84	60.52	6.69	18.70	3.86	4.92	2.84	2.33	1.72	0.69	1.21	0.29	0.78	0.10	0.45	0.03	0.29	0.01	0.20	0.00
20			12.04	73.56	7.43	22.72	4.29	5.98	3.15	2.83	1.91	0.84	1.34	0.35	0.87	0.12	0.50	0.03	0.32	0.01	0.22	0.00
25			15.05	111.20	9.29	34.35	5.37	9.05	3.94	4.27	2.39	1.27	1.68	0.53	1.09	0.19	0.63	0.05	0.40	0.02	0.28	0.01
30			18.06	155.86	11.14	48.15	6.44	12.68	4.73	5.99	2.87	1.78	2.01	0.75	1.30	0.26	0.76	0.07	0.48	0.02	0.33	0.01
35					13.00	64.06	7.51	16.87	5.52	7.97	3.35	2.36	2.35	1.00	1.52	0.35	0.88	0.09	0.56	0.03	0.39	0.01
40					14.86	82.03	8.59	21.60	6.31	10.20	3.83	3.03	2.68	1.27	1.74	0.44	1.01	0.12	0.64	0.04	0.44	0.02
45					16.72	102.03	9.66	26.87	7.10	12.69	4.31	3.76	3.02	1.58	1.95	0.55	1.13	0.15	0.72	0.05	0.50	0.02
50							10.73	32.66	7.88	15.43	4.78	4.57	3.35	1.93	2.17	0.67	1.26	0.18	0.80	0.06	0.56	0.02
60							12.88	45.77	9.46	21.62	5.74	6.41	4.02	2.70	2.61	0.94	1.51	0.25	0.96	0.08	0.67	0.03
70							15.02	60.90	11.04	28.77	6.70	8.53	4.69	3.59	3.04	1.25	1.77	0.33	1.12	0.11	0.78	0.05
80	8 -inch						17.17	77.98	12.62	36.84	7.65	10.92	5.36	4.60	3.47	1.60	2.02	0.43	1.28	0.14	0.89	0.06
90							19.32	96.99	14.19	45.81	8.61	13.58	6.03	5.72	3.91	1.99	2.27	0.53	1.44	0.18	1.00	0.07
100	Veloc. (fps)	Loss (ft)							15.77	55.69	9.57	16.51	6.71	6.95	4.34	2.42	2.52	0.64	1.60	0.21	1.11	0.09
110									17.35	66.44	10.52	19.70	7.38	8.30	4.78	2.88	2.77	0.77	1.77	0.26	1.22	0.10
120	0.77	0.03	10 -inch						18.92	78.05	11.48	23.14	8.05	9.75	5.21	3.39	3.03	0.90	1.93	0.30	1.33	0.12
130	0.83	0.04							20.50	90.53	12.44	26.84	8.72	11.31	5.65	3.93	3.28	1.05	2.09	0.35	1.44	0.14
140	0.89	0.04	Veloc. (fps)	Loss (ft)							13.39	30.79	9.39	12.97	6.08	4.51	3.53	1.20	2.25	0.40	1.56	0.16
150	0.96	0.05									14.35	34.99	10.06	14.74	6.51	5.12	3.78	1.37	2.41	0.45	1.67	0.19
160	1.02	0.05	0.65	0.02	12 -inch						15.31	39.43	10.73	16.61	6.95	5.77	4.04	1.54	2.57	0.51	1.78	0.21
170	1.09	0.06	0.69	0.02							16.26	44.11	11.40	18.58	7.38	6.46	4.29	1.72	2.73	0.57	1.89	0.23
180	1.15	0.07	0.74	0.02	Veloc. (fps)	Loss (ft)	14 -inch				17.22	49.04	12.07	20.65	7.82	7.18	4.54	1.91	2.89	0.64	2.00	0.26
190	1.21	0.07	0.78	0.03							18.18	54.20	12.74	22.83	8.25	7.93	4.79	2.11	3.05	0.70	2.11	0.29
200	1.28	0.08	0.82	0.03			Veloc. (fps)	Loss (ft)			19.13	59.60	13.41	25.10	8.69	8.73	5.04	2.33	3.21	0.77	2.22	0.32
225	1.44	0.10	0.92	0.03	0.64	0.01					21.53	74.13	15.09	31.22	9.77	10.85	5.67	2.89	3.61	0.96	2.50	0.39
250	**1.60**	**0.12**	**1.02**	**0.04**	**0.71**	**0.02**	**0.52**	**0.01**			**23.92**	**90.11**	**16.76**	**37.95**	**10.86**	**13.19**	**6.30**	**3.52**	**4.01**	**1.17**	**2.78**	**0.48**
275	1.76	0.15	1.12	0.05	0.78	0.02	0.57	0.01	16 -inch				18.44	45.28	11.94	15.74	6.94	4.19	4.41	1.40	3.06	0.57
300	1.92	0.17	1.23	0.06	0.85	0.02	0.63	0.01					20.12	53.20	13.03	18.49	7.57	4.93	4.81	1.64	3.33	0.67
325	2.08	0.20	1.33	0.07	0.92	0.03	0.68	0.01	Veloc. (fps)	Loss (ft)					14.11	21.44	8.20	5.72	5.22	1.90	3.61	0.78
350	2.24	0.23	1.43	0.08	0.99	0.03	0.73	0.02							15.20	24.60	8.83	6.56	5.62	2.18	3.89	0.89
375	2.40	0.26	1.53	0.09	1.06	0.04	0.78	0.02	0.60	0.01	18 -inch				16.29	27.95	9.46	7.45	6.02	2.48	4.17	1.01
400	2.55	0.30	1.64	0.10	1.14	0.04	0.83	0.02	0.64	0.01					17.37	31.50	10.09	8.40	6.42	2.80	4.44	1.14
425	2.71	0.33	1.74	0.11	1.21	0.05	0.89	0.02	0.68	0.01	Veloc. (fps)	Loss (ft)			18.46	35.24	10.72	9.39	6.82	3.13	4.72	1.28
450	2.87	0.37	1.84	0.12	1.28	0.05	0.94	0.02	0.72	0.01					19.54	39.18	11.35	10.44	7.22	3.48	5.00	1.42
475	3.03	0.41	1.94	0.14	1.35	0.06	0.99	0.03	0.76	0.01	0.60	0.01	20 -inch		20.63	43.30	11.98	11.54	7.62	3.84	5.28	1.57
500	3.19	0.45	2.04	0.15	1.42	0.06	1.04	0.03	0.80	0.02	0.63	0.01					12.61	12.69	8.02	4.23	5.56	1.73
600	3.83	0.63	2.45	0.21	1.70	0.09	1.25	0.04	0.96	0.02	0.76	0.01	Veloc. (fps)	Loss (ft)			15.13	17.79	9.63	5.92	6.67	2.42
700	4.47	0.84	2.86	0.28	1.99	0.12	1.46	0.06	1.12	0.03	0.88	0.02					17.65	23.67	11.23	7.88	7.78	3.22
800	5.11	1.07	3.27	0.36	2.27	0.15	1.67	0.07	1.28	0.04	1.01	0.02	0.82	0.01	24 -inch		20.18	30.31	12.84	10.09	8.89	4.13
900	5.75	1.33	3.68	0.45	2.55	0.19	1.88	0.09	1.44	0.05	1.14	0.03	0.92	0.02					14.44	12.55	10.00	5.13
1000	6.39	1.62	4.09	0.55	2.84	0.23	2.09	0.11	1.60	0.06	1.26	0.03	1.02	0.02	Veloc. (fps)	Loss (ft)			16.05	15.26	11.11	6.24
1100	7.03	1.94	4.50	0.65	3.12	0.27	2.29	0.13	1.76	0.07	1.39	0.04	1.12	0.02					17.65	18.20	12.22	7.44
1200	7.66	2.27	4.91	0.77	3.41	0.32	2.50	0.15	1.92	0.08	1.51	0.04	1.23	0.03	0.85	0.01			19.26	21.38	13.33	8.75
1300	8.30	2.64	5.31	0.89	3.69	0.37	2.71	0.17	2.08	0.09	1.64	0.05	1.33	0.03	0.92	0.01			20.86	24.80	14.45	10.14
1400	8.94	3.02	5.72	1.02	3.97	0.42	2.92	0.20	2.24	0.10	1.77	0.06	1.43	0.04	0.99	0.01	36 -inch				15.56	11.64
1500	9.58	3.44	6.13	1.16	4.26	0.48	3.13	0.23	2.40	0.12	1.89	0.07	1.53	0.04	1.06	0.02					16.67	13.22
1600	10.22	3.87	6.54	1.31	4.54	0.54	3.34	0.25	2.55	0.13	2.02	0.07	1.64	0.04	1.14	0.02	Veloc. (fps)	Loss (ft)			17.78	14.90
1700	10.86	4.33	6.95	1.46	4.83	0.60	3.55	0.28	2.71	0.15	2.14	0.08	1.74	0.05	1.21	0.02					18.89	16.67
1800	11.50	4.82	7.36	1.63	5.11	0.67	3.75	0.32	2.87	0.17	2.27	0.09	1.84	0.06	1.28	0.02	0.57	0.00			20.00	18.53
1900	12.14	5.33	7.77	1.80	5.39	0.74	3.96	0.35	3.03	0.18	2.40	0.10	1.94	0.06	1.35	0.03	0.60	0.00				
2000	12.77	5.86	8.18	1.98	5.68	0.81	4.17	0.38	3.19	0.20	2.52	0.11	2.04	0.07	1.42	0.03	0.63	0.00				
2100	13.41	6.41	8.58	2.16	5.96	0.89	4.38	0.42	3.35	0.22	2.65	0.12	2.15	0.07	1.49	0.03	0.66	0.00				
2200	14.05	6.99	8.99	2.36	6.25	0.97	4.59	0.46	3.51	0.24	2.78	0.14	2.25	0.08	1.56	0.03	0.69	0.00				
2300	14.69	7.59	9.40	2.56	6.53	1.05	4.80	0.50	3.67	0.26	2.90	0.15	2.35	0.09	1.63	0.04	0.73	0.01				
2400	15.33	8.21	9.81	2.77	6.81	1.14	5.01	0.54	3.83	0.28	3.03	0.16	2.45	0.10	1.70	0.04	0.76	0.01				
2500	15.97	8.85	10.22	2.99	7.10	1.23	5.21	0.58	3.99	0.30	3.15	0.17	2.55	0.10	1.77	0.04	0.79	0.01				
2750	17.56	10.56	11.24	3.57	7.81	1.47	5.74	0.69	4.39	0.36	3.47	0.20	2.81	0.12	1.95	0.05	0.87	0.01				
3000	19.16	12.41	12.26	4.19	8.52	1.73	6.26	0.82	4.79	0.43	3.78	0.24	3.07	0.14	2.13	0.06	0.95	0.01				