

F25902

PUMP DESIGN CALCULATIONS & GROUNDWATER MOUNDING ANALYSIS

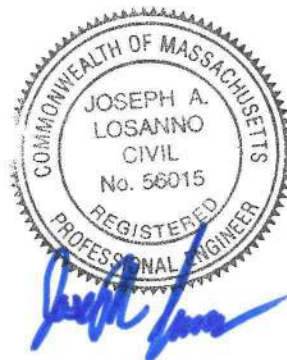
for the

WASHINGTON STREET SHERBORN HOMES

at

**0 WASHINGTON STREET IN
SHERBORN, MASSACHUSETTS 01770**

Prepared By: DGT Associates
1071 Worcester Road
Framingham, MA 01701



February 9, 2024

Pump Design Calculations

Washington Street Sherborn Homes

Total Daily Flow (Title 5):

Building Use: Multi-Family
Number of Bedrooms: 70 Bedrooms
Design Flow – Title 5: 110 GPD / Bedroom
Total Daily Design Flow: 7,700 Gallons

Pump Chamber Volume / Vertical Ft:

Volume/ft = $16.0 \text{ ft} \times 9.0 \text{ ft} \times 1 \text{ ft} \times 7.48 \text{ gal/ft}^3$
Volume/ft = 1,077 gallons/ft

Dose:

At a minimum, each dose shall clear the force main of the volume contained within.

Line Volume = $40.92 \text{ gallons/100 ft} \times 192.7 \text{ ft of Force Main} = 78.9 \text{ gallons}$

$66.12 \text{ gallons/100 ft} \times 113 \text{ ft of Manifold} = 74.7 \text{ gallons}$

Total Line Volume = $78.9 + 74.7 = 153.6 \text{ gallons}$

Design at 6 doses/day: $7,700 \text{ gallons} \div 6 = 1283.3 \text{ gallons/dose}$

Total Minimum Dose = $1283.3 + 153.6 = 1436.9 \text{ gallons/dose}$

Draw Depth:

Design Draw Depth = $1436.9 \text{ gallons/dose} / 1,077 \text{ gallons/ft} = 1.33 \text{ ft/dose}$

Use 1.35 ft = 1453 gallons/dose ← Okay

Storage Above Alarm:

Storage Volume = (Tank Volume in gal/ft) x (Invert In Elev – Alarm On Float Elev)

Storage Volume = $1,077 \text{ gal/ft} \times (210.5 - 202.85) \text{ ft} = 1,077 \text{ gal/ft} \times 7.15' = 7,700 \text{ gallons}$

$7,700 \text{ gallons} \div 7,700 \text{ gpd} = 1.0 \text{ days (24.0 hours)}$

Pump Run Time:

Pump operates at 180 gal/min

Pump Run Time = $1,453 \text{ gal} \div 180 \text{ gal/min}$

Pump Run Time = 8.0 minutes

TABLE 1
LINE VOLUMES IN GALLONS/100 FEET OF PIPE LENGTH

Pipe Size	SDR-26 PVC	SDR-21 PVC	Sch.40 PVC
1 1/4 inch	9.57	9.13	7.76
1 1/2 inch	12.55	11.97	10.57
2 inch	19.64	18.77	17.44
2 1/2 inch	28.65	27.68	24.91
3 inch	42.55	40.92	38.39
4 inch	70.39	67.47	66.12
6 inch	152.6	146.23	150.00
8 inch	258	248.11	n.a.

Job No.: F25902

Date: 2024-02-09

Head Loss in Force Main

STATIC HEAD

(H_s)

Discharge elev at Manifold	212.7
Pump off elevation	201.0
Total =	11.7

DYNAMIC HEAD

Pipe Length = 192.7 Ft

Pump Station:

Component	Pipe Size	Quantity	Equiv. Length	Total
				Equiv. Length
Check Valve	3"	1.0	19.5	19.5
90 deg. Elbow	3"	2.0	8.1	16.2
Ball Valve	3"	1.0	1.7	1.7
Total =				37.4

Force Main:

Component	Pipe Size	Quantity	Equiv. Length	Total
				Equiv. Length
45 deg. Elbow	3"	2.0	3.8	7.6
22.5 deg. Elbow	3"	1.0	1.9	1.9
Ball Valve (CO MH)	3"	2.0	1.7	3.4
90 deg. Elbow	3"	1.0	8.1	8.1
Tee (CO MH)	3"	3.0	5.0	15.0
Total =				36.0

Total Equivalent Pipe Length = 266.1 Ft (TEPL)

Job No.: F25902

Date: 2024-02-09

Total Dynamic Head Calculations

3" SDR-21 PVC PIPE

Total Equivalent Pipe Length = 266.1 (TEPL)
Static Head = 11.70 (H_s)

		A	B		C	A+B+C=
Flow GPM	V (ft / sec.)	$V^2 / 2g$ (ft)	$H_f / 100$ ft	$H_f \times \text{TEPL} / 100$ ft (ft)	H_s (ft)	TDH (ft)
70	2.95	0.14	1.17	3.11	11.70	14.95
80	3.36	0.18	1.49	3.96	11.70	15.84
90	3.79	0.22	1.87	4.98	11.70	16.90
100	4.21	0.28	2.27	6.04	11.70	18.02
125	5.26	0.43	3.49	9.29	11.70	21.42
150	6.31	0.62	4.85	12.91	11.70	25.22
175	7.37	0.84	6.48	17.24	11.70	29.79
200	8.42	1.10	8.39	22.33	11.70	35.13

s program is designed for CLASSROOM use. All calculations should be confirmed before using for a design.
will vary based on pipe roughness, orifice edges, fittings, fluid characteristics and other variables.
© Wayne Federal, 35 Revell Avenue, Northampton, MA 01060, wfeiden@k12s.phast.umass.edu OR
nical and Industrial Engineering, Engineering Lab, UMASS-Amherst, Amherst, MA 01003, winkler@esc.umass.edu

IF ERROR---PRESS ESCAPE

7700		
201		
212.7		
202		
3		
2.5		
no	GO TO MANIFOLD DESIGN	
0		
0	0.3125	
4	4	
111.5		
no		
14		
0.25		USE 0 IF FORCE MAIN DOES NOT DRAIN

[illegible]

FRICTION CALCULATIONS (using Hazen Williams friction $f_t = Ld / ((3.55Qm / Ch(Dd^{2.63})))^{1.85}$)
PRESSURE CALCULATIONS (using orifice discharge equation $Q = 11.79 D^2 h d^{.5}$)

[illegible]

WEEP HOLE DISCHARGE (usually a 1/4" weep hole)	3.53	weep hole=		0.25 inch										
VOID VOLUME IN DELIVERY PIPE	74.17													
VOID VOLUME IN MANIFOLD	68.54	Volume from Manifold Design												
VOID VOLUME IN EACH LATERAL	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28	12.28
TOTAL LATERAL VOID VOLUME	171.92													
MINIMUM DOSE VOLUME (based on void volume)	859.59	to		1719.19 MIN										
ACTUAL MINIMUM IS BASED ON DAILY DESIGN FLOW (weep hole, usually 1/4", not counted for dose, effluent is repumped during process and not counted for friction, except as fitting headloss)														
TOTAL HEAD LOSS IN EACH LATERAL	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
MAXIMUM TOTAL LATERAL HEADLOSS IN SYSTEM	0.09													
MANIFOLD HEADLOSS (center-fed unless manifold design)	0.41													
DELIVERY PIPE HEADLOSS	10.81	w/ delivery		3 inch diameter										
FITTING LOSS (headloss *.15)	0.38	add extra head if fittings are more than absolute minimum												
DISTAL PRESSURE HEAD	2.50													
STATIC HEAD (OFF-SWITCH TO HIGH LATERAL/MANIFOLD)	11.70													
HEADLOSS PUMP TO WEEPHOLE (assume 3' run)	0.17													

PUMP MUST BE ABLE TO PASS SOLIDS AT
or
After OTIS (network losses =1.3*distal head)

159.64 G.P.M
159.64 G.P.M.

26.06 FEET OF HEAD
28.45 FEET OF HEAD

GPM = all laterals plus manifold orifices plus weep hole
head is sum of static head and headloss shown
head is static head, delivery losses and network losses



FEATURES

Impeller: Cast iron, ASTM A48, Class 30, two vane semi-open, non-clog design with pump out vanes for mechanical seal protection. Balanced for smooth operation. Silicon bronze impeller is an option.

Casing: Heavy duty gray cast iron, ASTM A48, Class 30. Volute type casing with 3", 125#, ANSI flanged, horizontal discharge. Compatible with A10-30 cast iron or A10-30B cast iron and brass (non-sparking) guide rail assembly.

Dual Mechanical Seals: Silicon carbide vs. silicon carbide outer seal and ceramic vs. carbon inner seal, stainless steel metal parts, BUNA-N elastomers. Upper and lower shaft seals are positioned independently and are separated by an oil-filled chamber.

Shaft: 300 series stainless steel keyed design.

Fasteners: 300 series stainless steel.

Capable of running dry temporarily without damage to seals or motor.

WS_D3 Series

Model 3888D3

SUBMERSIBLE SEWAGE PUMPS

Wastewater

APPLICATIONS

Used in a variety of residential, commercial and industrial applications such as:

- Sewage systems, Flood and Pollution Control, Dewatering/Effluent, Farms, Hospitals, Trailer Courts, Motels

SPECIFICATIONS

Pump:

- Maximum solid size: 2.5"
- Discharge size: 3", 125 # ANSI flange
- Maximum capacity: 470 GPM
- Maximum total head: 65 feet
- 300 Series stainless steel fasteners
- 20' Power cord
- Standard silicon carbide/silicon carbide outer seal

Motor:

- Maximum ambient temperature: 104° F (40° C) continuous duty, 140° F (60° C) intermittent duty
- Rated for continuous duty when fully submerged
- Insulation: Class F
- 60 Hertz
- Single row ball bearings
- 300 Series stainless steel keyed shaft

Single Phase:

- 1.5 - 5 HP; 208 and 230 volts
- Built-in thermal overloads with automatic reset
- Built-in capacitors

Three Phase:

- 1.5 - 5 HP; 200, 230, 460 and 575 volts
- Class 10 overload protection must be provided in control panel

MOTORS

- Fully submerged in oil-filled chamber: High grade turbine oil surrounds motor for more efficient heat dissipation, permanent lubrication of bearings and mechanical seal for complete protection against outside environment.
- Class F insulation
- Designed for Continuous Operation: Pump ratings are within the motor manufacturer's recommended working limits and can be operated continuously without damage when fully submerged.
- Bearings: Upper and lower heavy duty ball bearing construction for precision positioning of parts and to carry thrust loads.
- Power Cable: Severe duty rated, oil and water resistant. Epoxy seal on motor end provides secondary moisture barrier in case of outer jacket damage and to prevent oil wicking. 20 foot standard with optional lengths available.
- O-ring: Assures positive sealing against contaminants and oil leakage.

AGENCY LISTINGS



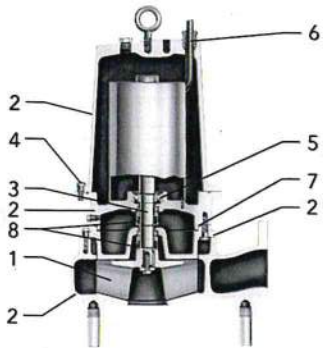
Tested to UL 778 and CSA 22.2 108 Standards
By Canadian Standards Association
File #LR38549

MODEL AND MOTOR INFORMATION

Order Number	HP	Phase	Volts	RPM	Impeller Diameter (in.)	Maximum Amps	Locked Rotor Amps	KVA Code	Power Cable	Full Load Motor Efficiency %	Resistance		Weight (lbs.)
											Start	Line-Line	
WS1518D3M	1.5	1	208	1750	5.25	15.0	50.8	B	14/3	80	1.1	0.9	192
WS1512D3M			230			12.5	29.5	E		70	1.4	1.8	
WS1538D3M			200			11.5	40.9	H		81		1.7	
WS1532D3M		3	230			10.0	40.0	F	14/4	83	NA	2.3	190
WS1534D3M			460			5.0	20.0	F		83		9.3	
WS1537D3M			575			4.0	14.4	H		74		14.8	
WS1518D3		1	208		6.50	15.0	50.8	B	14/3	80	1.1	0.9	192
WS1512D3			230			12.5	29.5	E		70	1.4	1.8	
WS1538D3			200			11.5	40.9	H		81		1.7	
WS1532D3		3	230			10.0	40.0	F	14/4	83	NA	2.3	190
WS1534D3			460			5.0	20.0	F		83		9.3	
WS1537D3			575			4.0	14.4	H		74		14.8	
WS2018D3	2	1	208	1750	7.00	19.0	50.8	B	14/3	80	1.1	0.9	196
WS2012D3			230			16.0	36.9	D		75	1.4	1.5	
WS2038D3			200			11.5	40.9	H		81		1.7	
WS2032D3		3	230			10.0	40.0	F	14/4	83	NA	2.3	194
WS2034D3			460			5.0	20.0	F		83		9.3	
WS2037D3			575			4.0	14.4	H		74		14.8	
WS3018D3		3	208		7.25	25.5	50.8	B	10/3	80	1.1	0.9	205
WS3012D3			230			21.5	46.4	C		79	1.0	1.0	
WS3038D3			200			15.2	53.8	G	14/4	85	NA	1.3	200
WS3032D3			230			12.0	49.5	H		83		1.9	
WS3034D3			460			6.0	24.8	H		83		7.5	
WS3037D3			575			4.8	17.3	G		78		11.6	
WS5012D3	5	1	230	1750	8.00	26.5	57.7	A	10/3	80	1.0	0.8	210
WS5038D3			200			18.8	73.9	F		84	NA	0.9	
WS5032D3		3	230			16.4	63.6	E	10/4	85		1.2	205
WS5034D3			460			8.2	31.8	E		85		4.8	
WS5037D3			575			6.8	22.8	E	14/4	80		7.4	

Wastewater

MATERIALS OF CONSTRUCTION

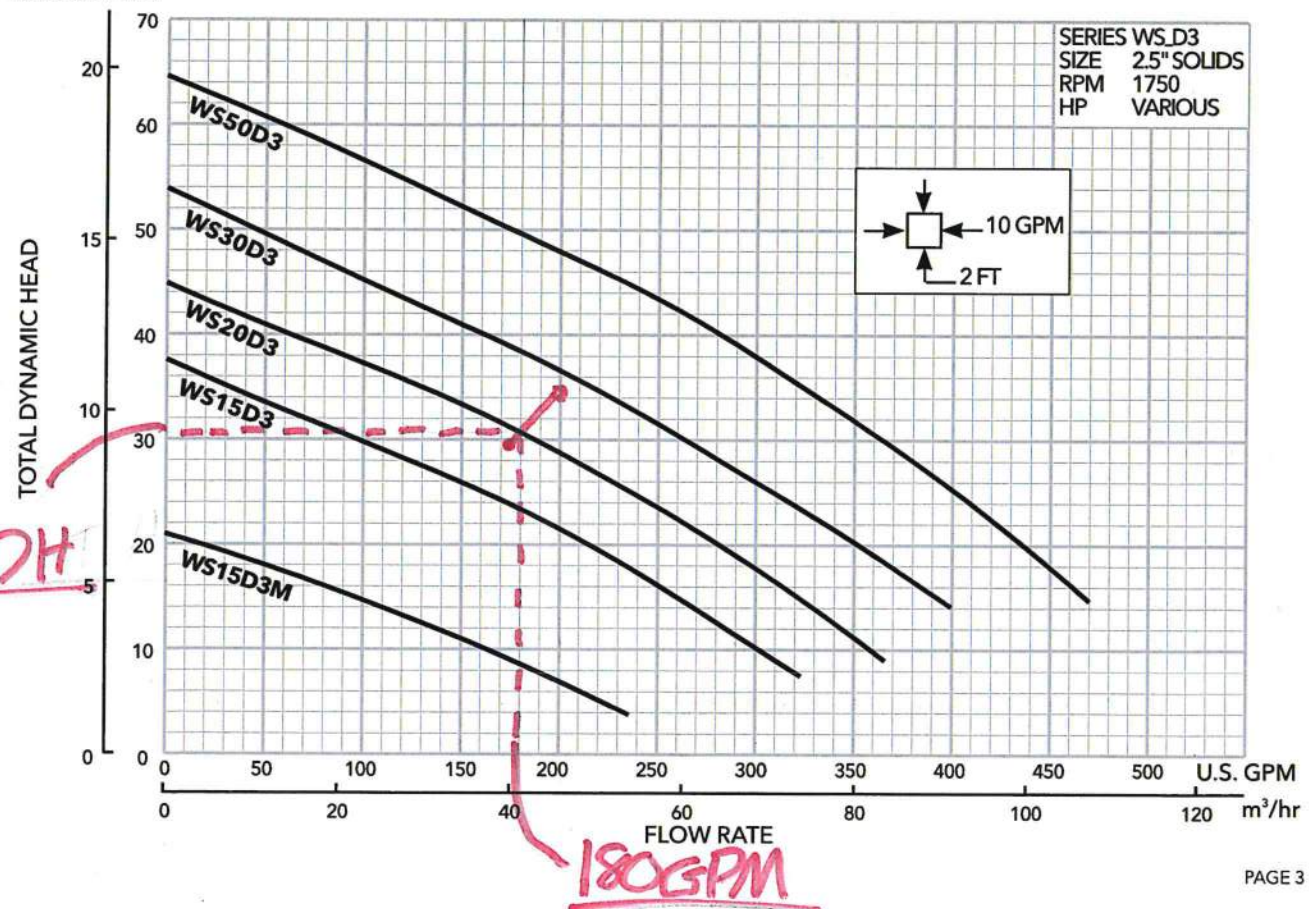


Item No.	Part Name	Material			
		Standard	Optional		
1	Impeller, non-clog	1003	1179		
2	Castings	1003			
3	Shaft-keyed	300 Series SS			
4	Fasteners	300 Series SS			
5	Ball bearings	Steel			
6	Power cable	STOW, 20 feet	Additional lengths		
7	O-ring	BUNA-N			
8	Outer Mech. Seal	Service	Rotary	Stationary	Elastomers
	OPT	Heavy duty	Silicon Carbide	Tungsten Carbide	BUNA-N
	STD	Mild abrasives	Silicon carbide	BUNA-N	300 Series SS
Material Code		Engineering Standard			
1003		Cast iron – ASTM A48 Class 30			
1179		Silicon bronze – ASTM C87600			

PERFORMANCE RATINGS (gallons per minute)

Series No. ▶	WS15D3M	WS15D3	WS20D3	WS30D3	WS50D3
HP ▶	1½	1½	2	3	5
RPM ▶	1750				
Total Head Feet of Water	10	160	300		
	15	90	260	320	
	20		210	280	435
	25		160	235	400
	30		100	185	360
	35			130	325
	40			60	280
	45			100	230
	50				170
	55				115
	60				60

METERS FEET

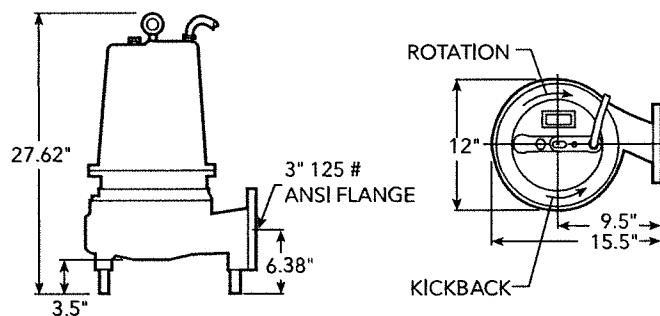


APPLICATION DATA AND CONSTRUCTION DETAILS

Maximum Solid Size	2.5"
Minimum Casing Thickness	$\frac{5}{16}$ "
Casing Corrosion Allowance	$\frac{1}{8}$ "
Maximum Working Pressure	30 PSI
Maximum Submergence	50 feet
Minimum Submergence	Fully submerged for continuous operation 6" below top of motor for intermittent operation
Maximum Environmental Temperature	40° C (104° F) continuous operation, 60° C (140° F) intermittent operation
Power Cable - Type (See Motor Information for AWG data/size.)	Type SJTOW: single phase, 1½ and 2 HP Type STOW: single phase, 1½ - 3 HP and 5 HP, 460 V Type STOW: single phase, 3 and 5 HP, three phase 5 HP, 230 V
Motor Cover, Bearing Housing, Seal Housing, Casing	Gray Cast Iron - ASTM A48, Class 30
Impeller - Standard, Optional	Gray Cast Iron - ASTM A48 or Cast Bronze - ASTM B584 C87600
Motor Shaft	AISI 300 Series Stainless Steel
Motor Design	NEMA 56 Frame, oil filled with Class F Insulation
Motor Overload Protection	Single phase: on winding thermal overload protection auto reset Three phase: requires Class 10 overloads in control panel
External Hardware	300 Series Stainless Steel
Impeller Type	Semi-open with pump out vanes on back shroud
Oil Capacity - Seal Chamber	1.5 quarts
Oil Capacity - Motor Chamber	1½-5 HP single and three phase: 7 quarts
Mechanical Seals - Standard	Upper Carbon/Ceramic; Type 21 Lower Silicon Carbide/Silicon Carbide; Type 31
Mechanical Seals - Optional Lower	Silicon Carbide/Tungsten Carbide; Type 31

DIMENSIONS

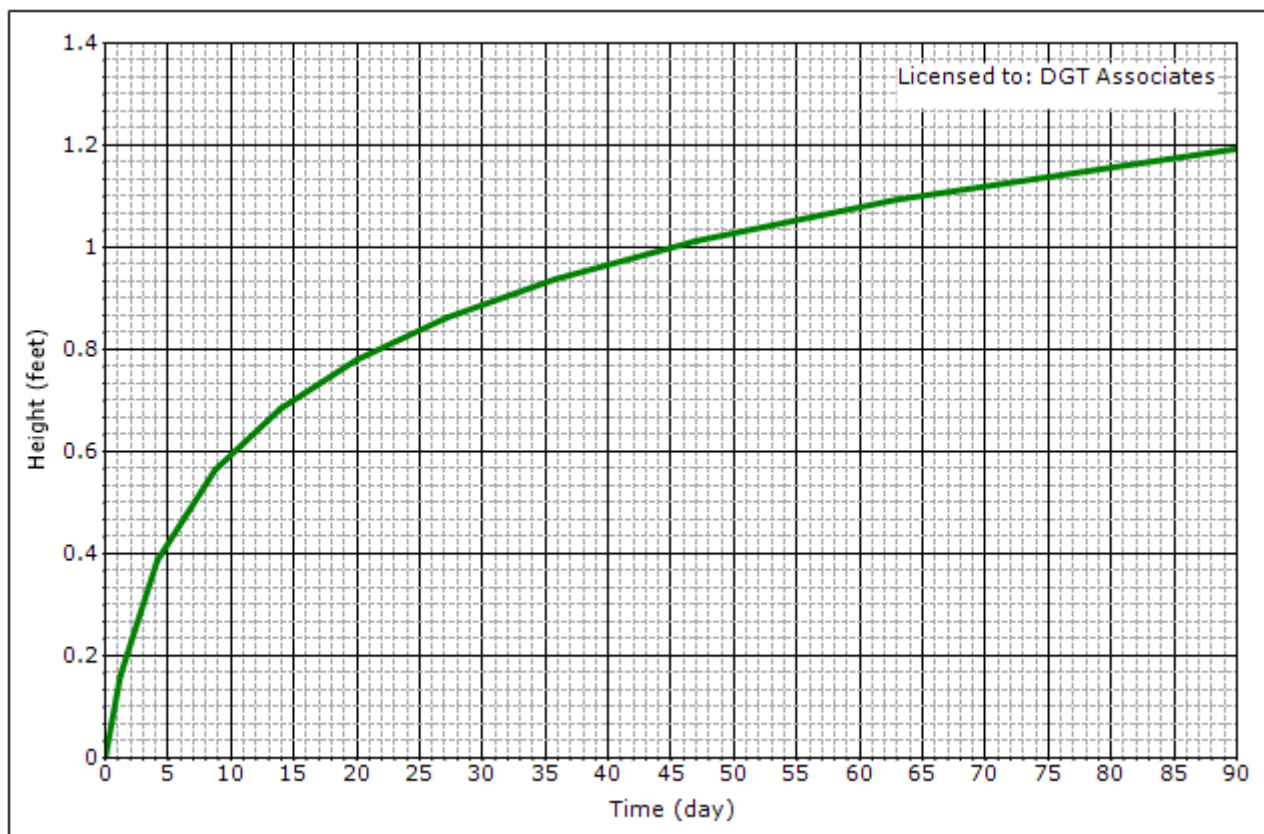
(All dimensions are in inches. Do not use for construction purposes.)



Xylem, Inc.
2881 East Bayard Street Ext., Suite A
Seneca Falls, NY 13148
Phone: (866) 325-4210
Fax: (888) 322-5877
www.xyleminc.com/brands/gouldswatertechnology

Goulds is a registered trademark of Goulds Pumps, Inc. and is used under license.
SKF is a registered trademark of Aktiebolaget SKF, Sweden.
© 2012 Xylem Inc. B3888D3 R1 April 2012

Groundwater Mounding Analysis (Hantush Method using Glover's Solution)



Company: DGT Associates
Project: F25902-Washington
Street, Sherborn
Analyst: Joseph A. Losanno,
P.E.
Date: 02/12/2024

<u>Time (d)</u>	<u>Height (ft)</u>
-----------------	--------------------

0.00	0.0000
------	--------

1.19	0.1607
------	--------

4.12	0.3863
------	--------

8.72	0.5641
------	--------

13.94	0.6845
-------	--------

19.96	0.7796
-------	--------

27.09	0.8620
-------	--------

35.81	0.9381
-------	--------

47.06	1.0133
-------	--------

62.91	1.0936
-------	--------

90.00	1.1933
-------	--------

Recharge Basin Dimensions

Length (w): 156.5 ft

Width (l): 110 ft

Bottom Area: 17,215 ft²

SHGW Separation: 4 ft

Recharge Rate Calculations

Duration (t): 90 d

Volume (V): 495 ft³

Rate (R): 0.02875 ft/d

Total Simulation Time: 90 d

Aquifer Characteristics

Hydraulic Conductivity (Kh): 14.31 ft/d

Drainable Porosity(Sy): 0.195

Saturated Thickness (h): 9.75 ft

Plot Geometry

X-Coordinate: 0 ft

Y-Coordinate: 0 ft

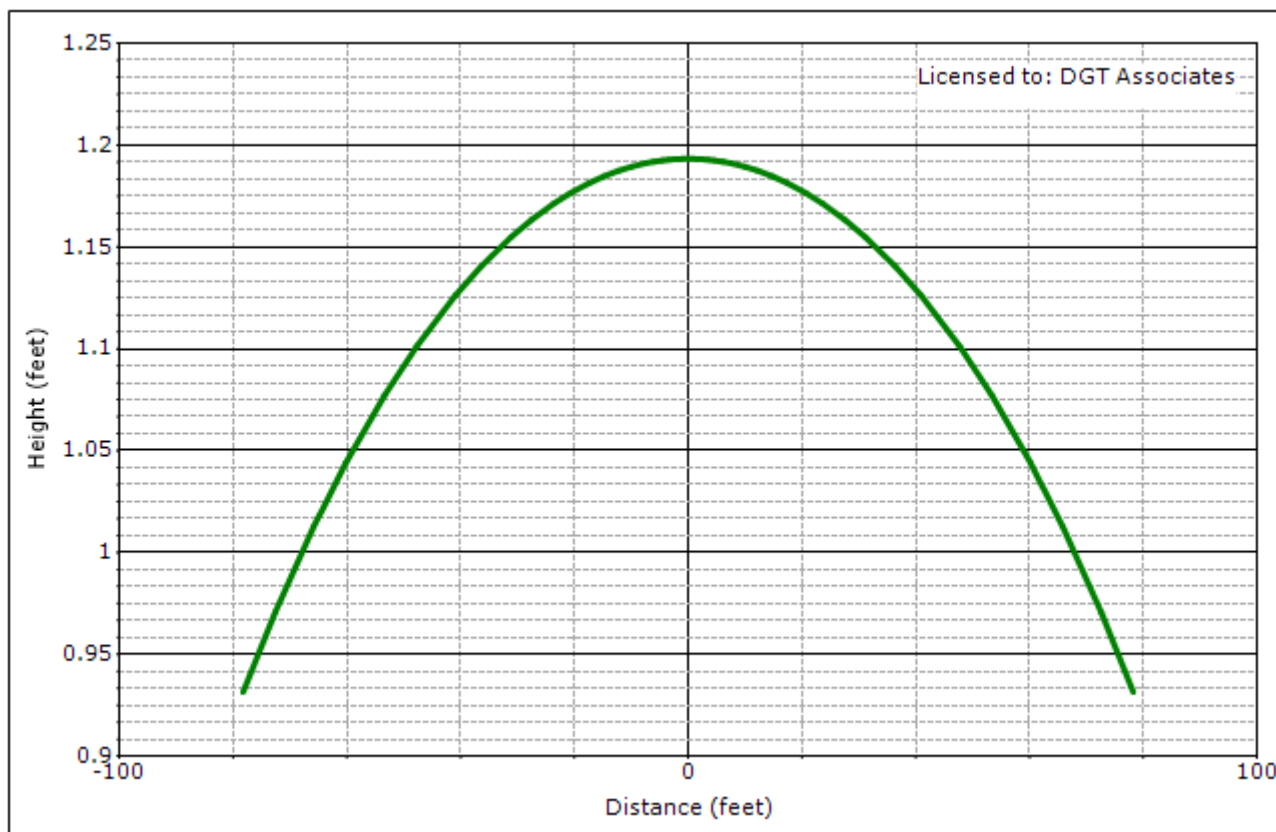
Left Side Plot Distance (Dl): 78.25 ft

Right Side Plot Distance (Dr): 78.25 ft

Plot Angle From Y-Axis (Φ): 0

Constant Head Boundary: No

Groundwater Mounding Analysis (Hantush Method using Glover's Solution)



Company: DGT Associates
 Project: F25902-Washington
 Street, Sherborn
 Analyst: Joseph A. Losanno,
 P.E.
 Date: 02/12/2024

Recharge Basin Dimensions

Length (w): 156.5 ft
 Width (l): 110 ft
 Bottom Area: 17,215 ft²
 SHGW Separation: 4 ft

Recharge Rate Calculations

Duration (t): 90 d
 Volume (V): 495 ft³
 Rate (R): 0.02875 ft/d
 Total Simulation Time: 90 d

Aquifer Characteristics

Hydraulic Conductivity (Kh): 14.31 ft/d
 Drainable Porosity(Sy): 0.195
 Saturated Thickness (h): 9.75 ft

Plot Geometry

X-Coordinate: 0 ft
 Y-Coordinate: 0 ft
 Left Side Plot Distance (Dl): 78.25 ft
 Right Side Plot Distance (Dr): 78.25 ft
 Plot Angle From Y-Axis (Φ): 0
 Constant Head Boundary: No

<u>Distance</u> <u>(ft)</u>	<u>Height</u> <u>(ft)</u>	<u>Distance</u> <u>(ft)</u>	<u>Height</u> <u>(ft)</u>
-78.25	0.9314	0.00	1.1933
-72.60	0.9706	1.25	1.1932
-65.81	1.0128	2.46	1.1931
-60.15	1.0441	3.52	1.1928
-53.36	1.0772	4.54	1.1925
-47.70	1.1013	6.10	1.1918
-40.92	1.1262	7.58	1.1911
-36.38	1.1405	9.93	1.1894
-31.14	1.1549	12.12	1.1875
-27.55	1.1633	14.84	1.1847
-23.55	1.1714	17.36	1.1815
-20.60	1.1766	20.60	1.1766
-17.36	1.1815	23.55	1.1714
-14.84	1.1847	27.55	1.1633
-12.12	1.1875	31.14	1.1549
-9.93	1.1894	36.38	1.1405
-7.58	1.1911	40.92	1.1262
-6.10	1.1918	47.70	1.1013
-4.54	1.1925	53.36	1.0772
-3.52	1.1928	60.15	1.0441
-2.46	1.1931	65.81	1.0128
-1.25	1.1932	72.60	0.9706
		78.25	0.9314