

GROUNDWATER MOUNDING CALCULATIONS
TIMBER CREST ESTATES, MEDWAY, MA
September 7, 2017

This groundwater mounding analysis was prepared to accompany the Conservation Permitting Plans for Timber Crest Estates, dated August 25, 2017 and Notice of Intent filing. Per the DEP Stormwater Management Regulations, groundwater mounding beneath infiltration systems within jurisdiction of the Wetlands Protection Act are required when the bottom of an infiltration drainage system is within 4 ft. of the seasonal high water table. The attached table summarizes the mound heights calculated at each such BMP for the 100-yr. storm, and notes the available separation to groundwater before the mound occurs.

The groundwater mounding calculations were performed using software developed by GeoHydroCycle, Inc. of Natick MA. This software program is based on the Hantush Method using Glover's Solution. Using the Hantush Method, a number of input parameters are required in order to compute the groundwater mound height. All input parameters used have been derived using standard practices and readily available information from the site plans, soil test pits and drainage calculations prepared for the project. The following are the input parameters used in the mounding calculations:

Application Rate: Is the volume of water that is infiltrated by each BMP in the 100-yr. storm (denoted as "Discarded Volume" in the provided HydroCAD calculations) divided by the wetted area of the infiltration practice.

Duration of Application: The duration is 1 day to match the 100-year, 24-hour storm events.

Fillable Porosity: This is a value based on the soil classification found at the location of the infiltration practice. The attached graph by Walton demonstrates the porosity for all soil types in this case can be fairly characterized as 0.35.

Hydraulic Conductivity: The values used in the Hantush method were estimated based on the attached graph by Anderson & Woessner and our assessment of the soil test pits performed within the infiltration BMP on site; 9 ft/day for Sandy Loams, 60 ft/day for Loamy Sands, and 200 ft/day for Coarse Sands & Gravels.

Initial Saturated Thickness: This value represents the depth to the highest natural restrictive layer (clay or bedrock). In a few cases bedrock was encountered in the on-site observation holes so the actual observed depth was used. When it was not observed this value was estimated from a Well Completion Report from the MassDEP Search Well database, where the well is located at 9 Ohlson Circle (see attached well report), and the initial saturated thickness is the depth to bedrock in the well report (20').

Length of application area: The length of the proposed infiltration practice bottom.

Width of application area: The width of the proposed infiltration practice bottom.

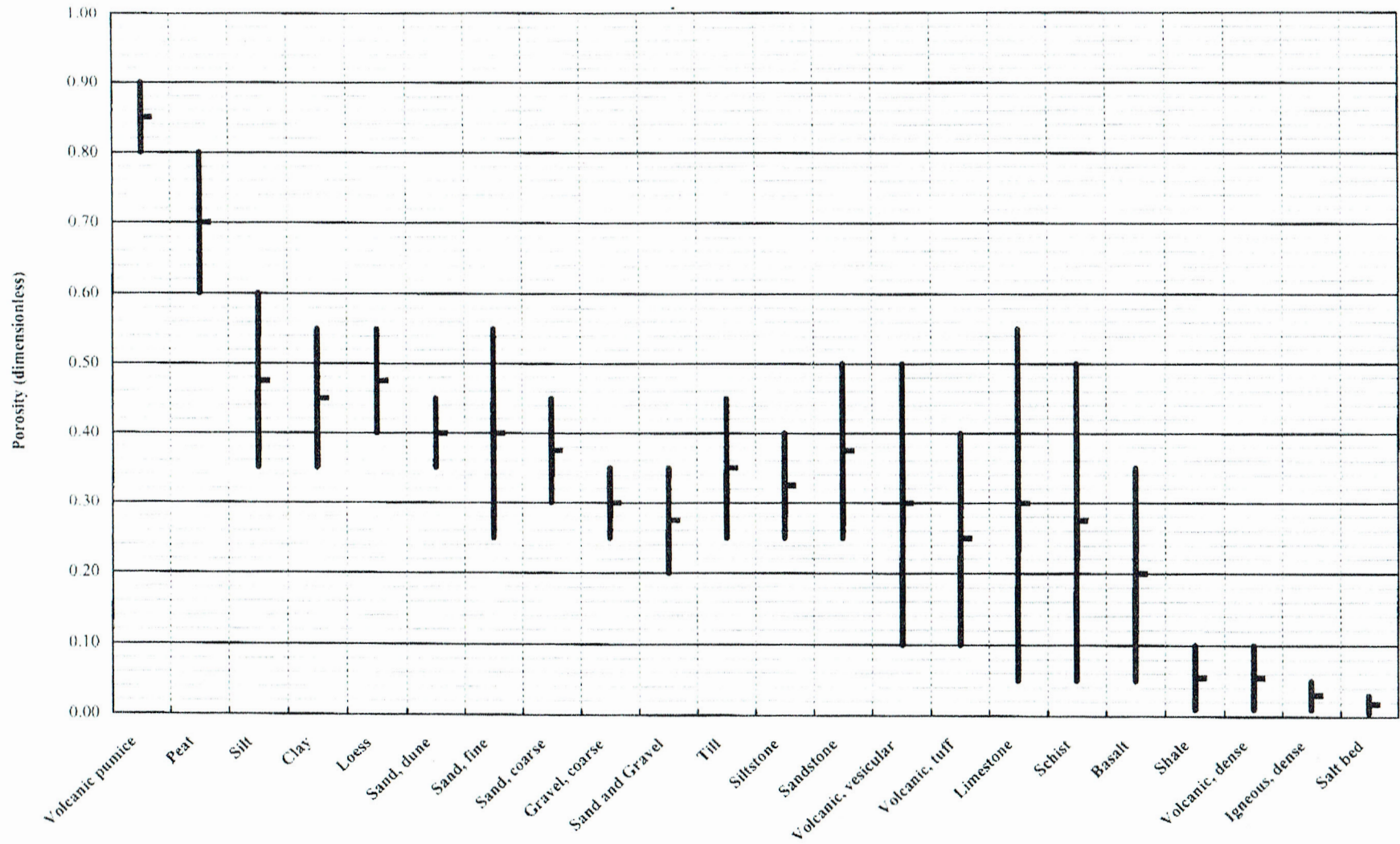
GROUNDWATER MOUNDING SUMMARY
TIMBER CREST ESTATES, MEDWAY

September 7, 2017

Infiltration Practice	Discarded Volume (acre-feet)	Length of Application (ft)	Width of Application (ft)	Application Rate (ft ³ /day/ft ²)	Duration of Application	Fillable Porosity	Hydraulic Conductivity (ft/day)	Saturated Thickness (ft)	Mound Height * (ft)	Separation to Groundwater (ft)
Infiltration Basin 2	0.505	100	15	14.67	1 day	0.35	200	20	1.8	2.1
Inf. Basin 5	0.303	105	50	2.51			60	20	2.13	3.4
Inf. Basin 6	0.542	120	40	4.92			60	20	3.71	3.8
Inf. Basin 12	0.433	55	45	7.62			200	20	1.67	2.3
Inf. Basin 13	0.224	65	10	15.01			60	20	2.44	2.9
Inf. Basin 15	0.050	45	12	4.03			60	20	0.63	2.9
Leaching Chamber 3	0.169	172	11.33	3.78			60	20	1.03	3.2
Leaching Chamber 4	0.024	35.5	16.5	1.78			9	20	1.24	3.7
Rain Garden 1	0.141	60	45	1.89			60	8	2.19	2.2
Rain Garden 2	0.022	180	3	1.77			60	20	0.13	2.6
Rain Garden 3	0.011	155	3	1.03			60	20	0.07	2.1
Rain Garden 6	0.056	50	24	2.03			60	20	0.62	2.7

* see attached Groundwater Mounding Analysis calculation sheets

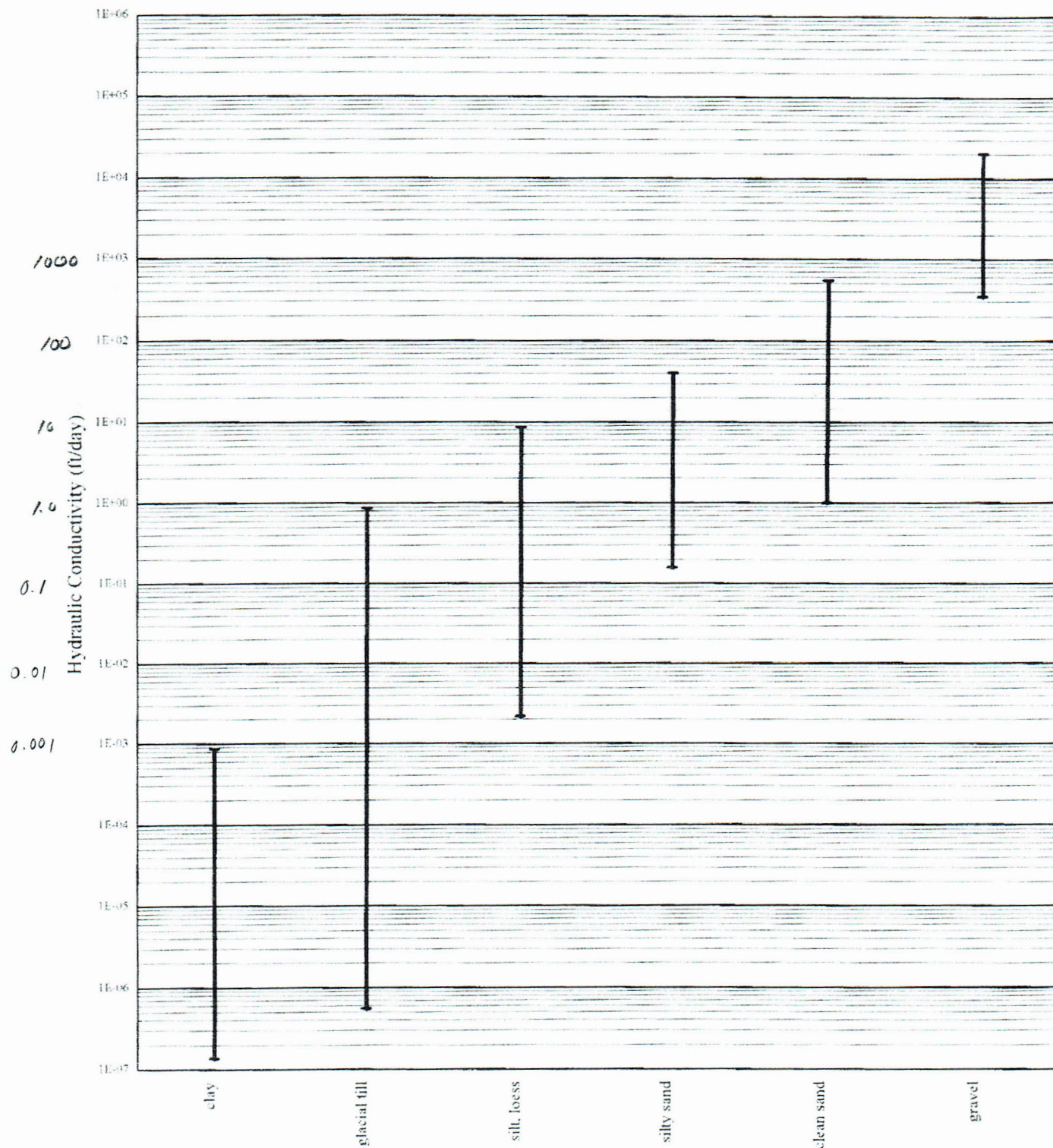
Porosity
Walton, William C., 1989, Analytical Groundwater Modeling, p. 141.



Ranges of Hydraulic Conductivity - Unconsolidated Materials

Anderson & Woessner, 1992

p. 46



MassDEP
Well Completion Report

8/24/2017 12:00:33 PM

WELL LOCATION

GPS North:
Address: 9 Ohlson Circle
Subdivision Name:
City/Town: Medway

GPS West:

Assessors Map:
Assessors Lot #:
Permit number:
Date Issued:
Board of Heath permit obtained: NR

Work Performed

New Well

Proposed Use

Domestic

Drilling Method Overburden

Drilling Method Bedrock

ADDITIONAL WELL INFORMATION

Developed : No
Disinfected : No
Total Well Depth : 340
Fracture Enhancement : No
Well Seal Type :
Depth to Bedrock : 20

PERMANENT PUMP (IF AVAILABLE)

Pump description :
Type :
Nominal Pump Capacity :
Intake Depth :
Horsepower :
Comments :

CASING

<u>From (ft)</u>	<u>To (ft)</u>	<u>Type</u>	<u>Thickness</u>	<u>Diameter</u>
35(Above Ground)	15	Steel		6

SCREEN

<u>From (ft)</u>	<u>To (ft)</u>	<u>Type</u>	<u>Slot Size</u>	<u>Diameter</u>
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WELL SEAL / FILTER PACK / ABANDONMENT MATERIAL

<u>From (ft)</u>	<u>To (ft)</u>	<u>Material Description</u>	<u>Purpose</u>
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STATIC WATER LEVEL (ALL WELLS)

<u>Date Measured</u>	<u>Depth Below Ground Surface (ft)</u>
05/20/1999	20

WELL TEST DATA (ALL SECTIONS MANDATORY FOR PRODUCTION WELLS)

<u>Date</u>	<u>Method</u>	<u>Yield (GPM)</u>	<u>Time Pumped (hrs & min)</u>	<u>Pumping Level (Ft. BGS)</u>	<u>Time To Recover (Hrs & Min)</u>	<u>Recovery (Ft. BGS)</u>
	Air Lift	25	00:30:00	340	00:12:00	20

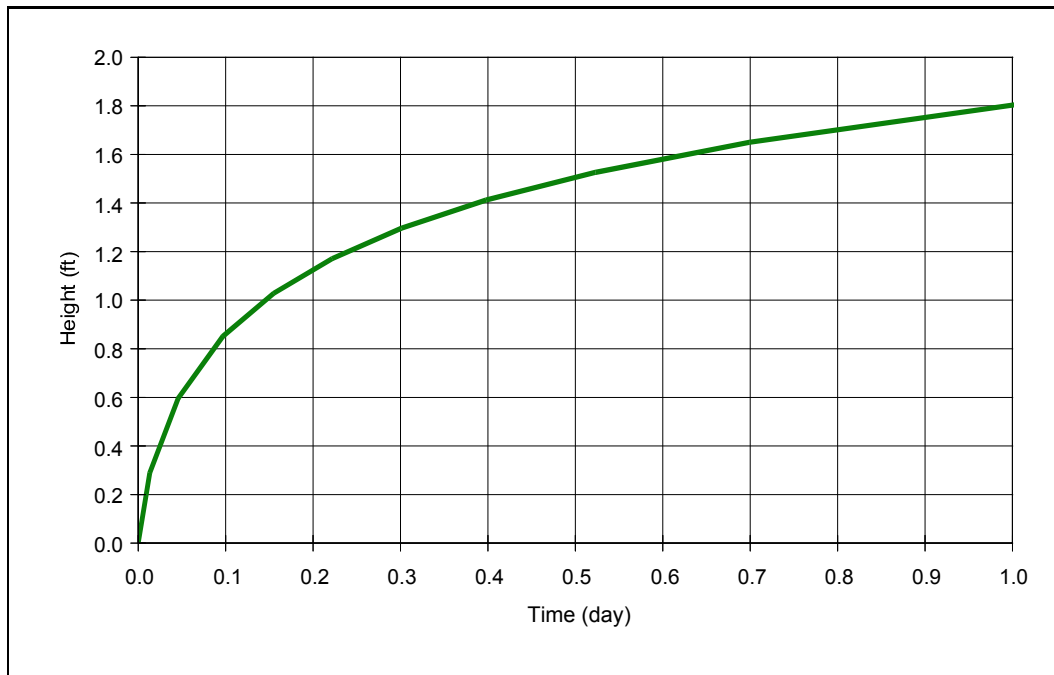
OVER BURDEN

<u>From (ft)</u>	<u>To (ft)</u>	<u>Lithology</u>	<u>Color</u>	<u>Comment</u>	<u>Water Zone</u>	<u>Loss/Add of fluid</u>	<u>Drill Stem Drop</u>	<u>Drill Rate</u>
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BEDROCK

<u>From (ft)</u>	<u>To (ft)</u>	<u>Lithology</u>	<u>Comment</u>	<u>Water Zone</u>	<u>Drill Stem Drop</u>	<u>Extra Large</u>	<u>Drill Rate</u>	<u>Rust Stain</u>	<u>Loss/Add of fluid</u>	<u># of Fract per ft</u>
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Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: BASIN 2 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:54:56 PM

INPUT PARAMETERS

Application rate: 14.67 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 200 ft/day

Initial saturated thickness: 20 ft

Length of application area: 100 ft

Width of application area: 15 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

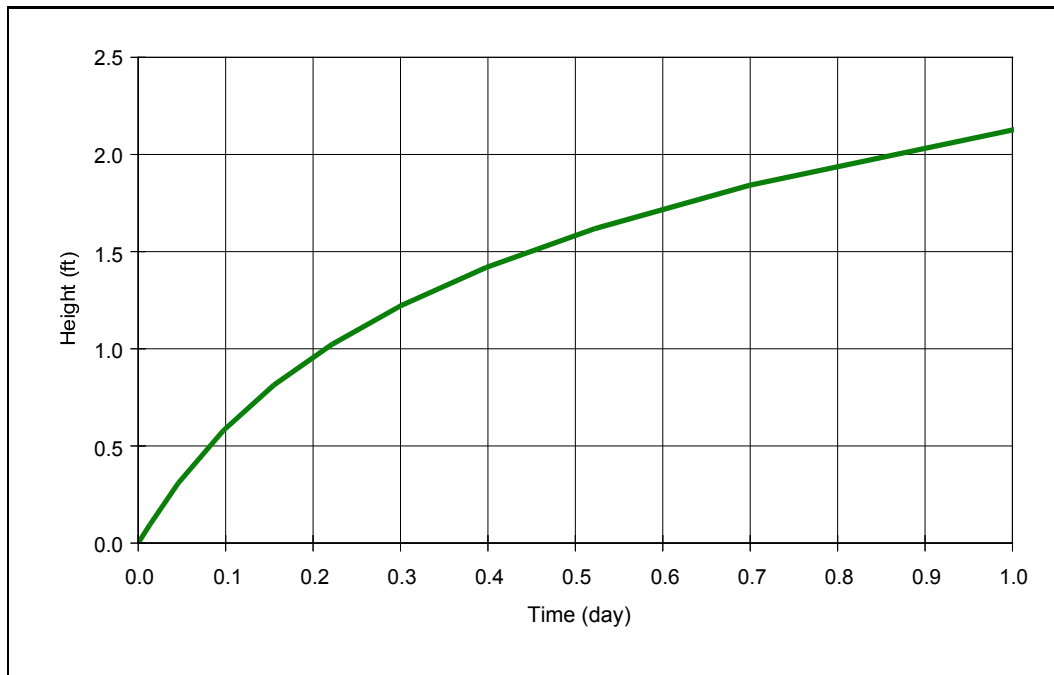
Y coordinate: 0 ft

Total volume applied: 22005 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.29
0	0.6
0.1	0.85
0.2	1.03
0.2	1.17
0.3	1.3
0.4	1.41
0.5	1.53
0.7	1.65
1	1.8

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: BASIN 5 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:56:11 PM

INPUT PARAMETERS

Application rate: 2.51 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 105 ft

Width of application area: 50 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

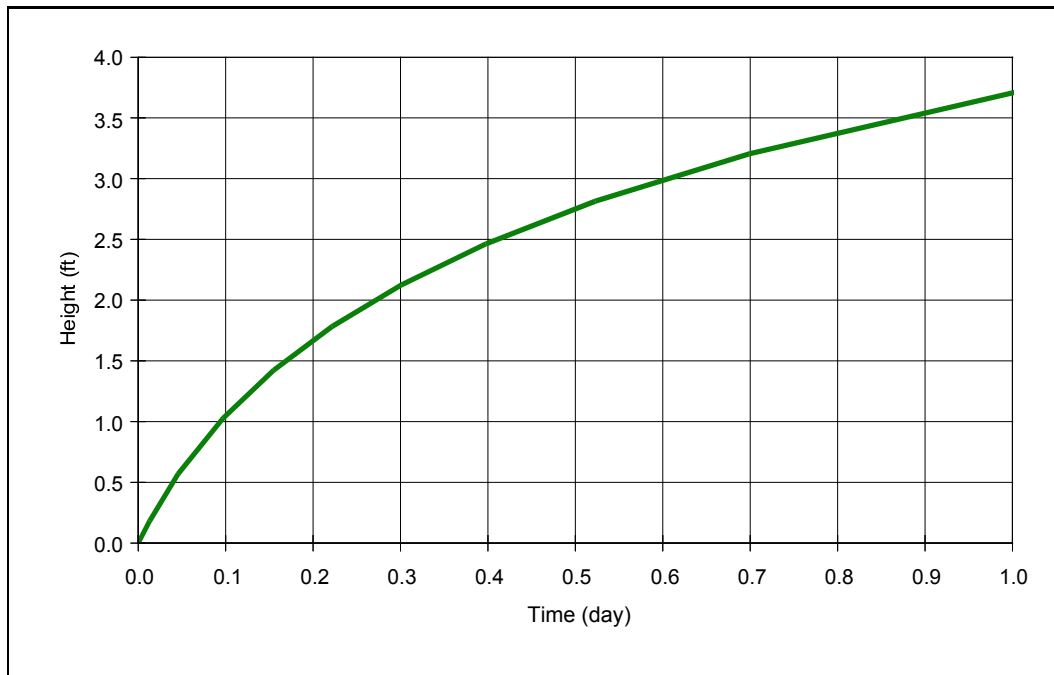
Y coordinate: 0 ft

Total volume applied: 13177.5 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.09
0	0.31
0.1	0.58
0.2	0.81
0.2	1.02
0.3	1.22
0.4	1.42
0.5	1.62
0.7	1.84
1	2.13

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: BASIN 6 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:56:31 PM

INPUT PARAMETERS

Application rate: 4.92 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 120 ft

Width of application area: 40 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

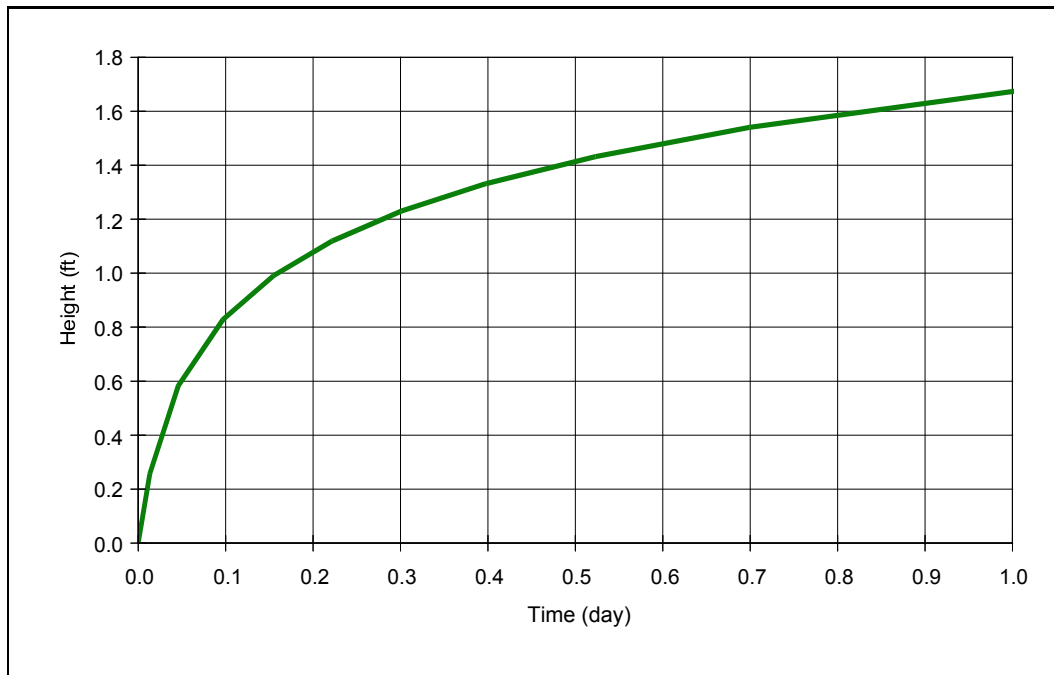
Y coordinate: 0 ft

Total volume applied: 23616 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.18
0	0.57
0.1	1.03
0.2	1.42
0.2	1.78
0.3	2.13
0.4	2.46
0.5	2.82
0.7	3.2
1	3.71

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: BASIN 12 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:57:12 PM

INPUT PARAMETERS

Application rate: 7.62 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 200 ft/day

Initial saturated thickness: 20 ft

Length of application area: 55 ft

Width of application area: 45 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

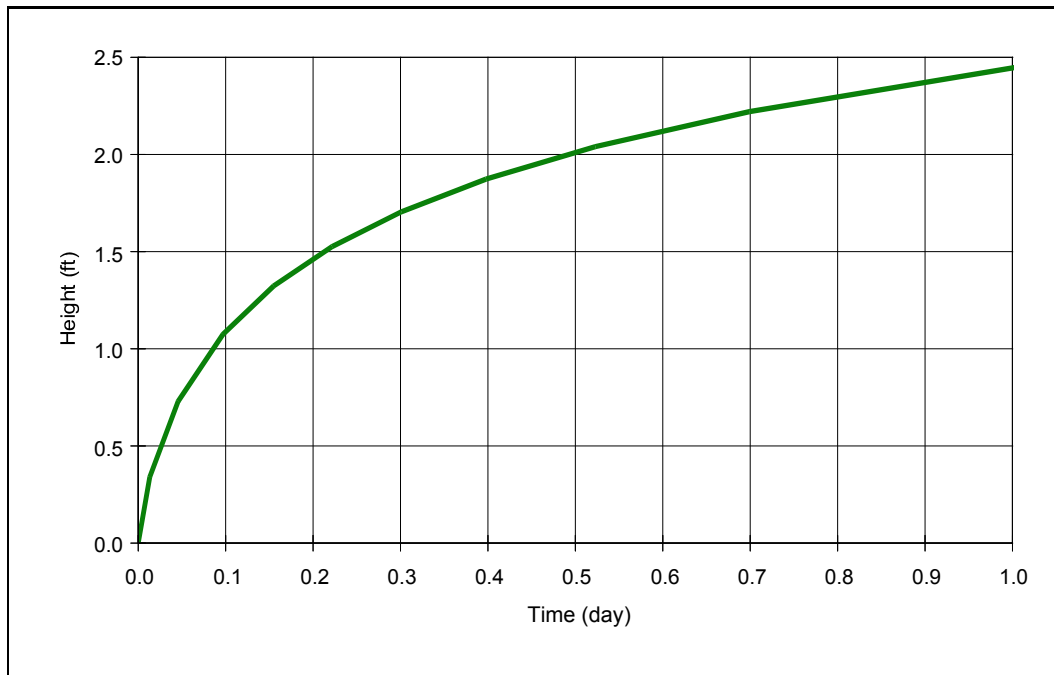
Y coordinate: 0 ft

Total volume applied: 18859.5 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.26
0	0.58
0.1	0.83
0.2	0.99
0.2	1.12
0.3	1.23
0.4	1.33
0.5	1.43
0.7	1.54
1	1.67

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: BASIN 13 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:57:29 PM

INPUT PARAMETERS

Application rate: 15.01 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 65 ft

Width of application area: 10 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

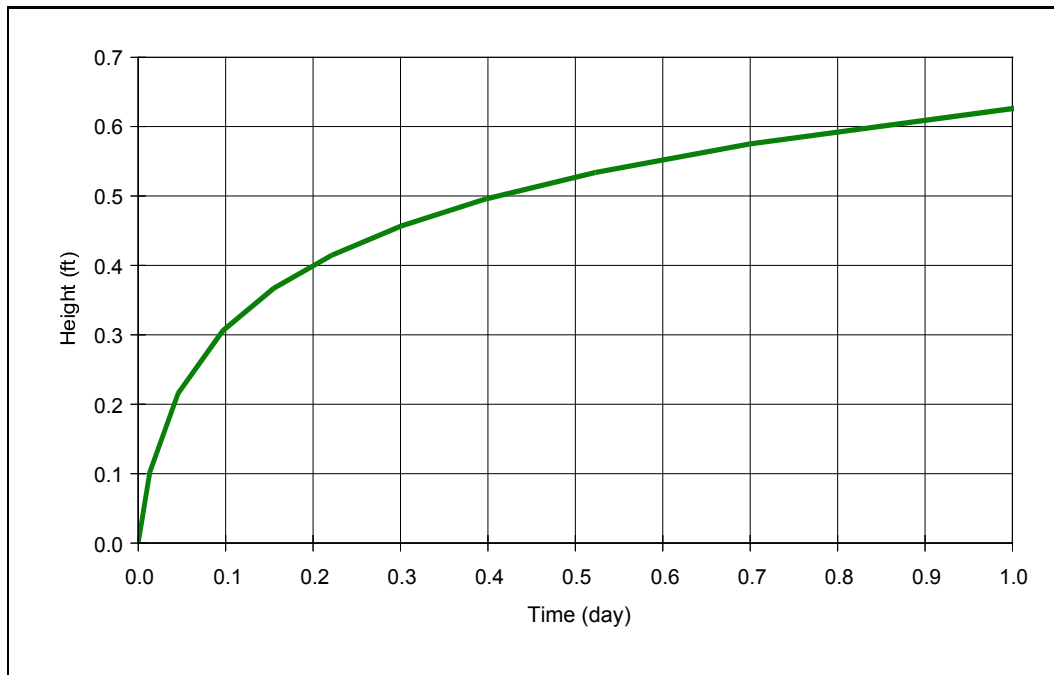
Y coordinate: 0 ft

Total volume applied: 9756.5 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.34
0	0.73
0.1	1.07
0.2	1.32
0.2	1.53
0.3	1.7
0.4	1.87
0.5	2.04
0.7	2.22
1	2.44

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: BASIN 15 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:57:47 PM

INPUT PARAMETERS

Application rate: 4.03 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 45 ft

Width of application area: 12 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

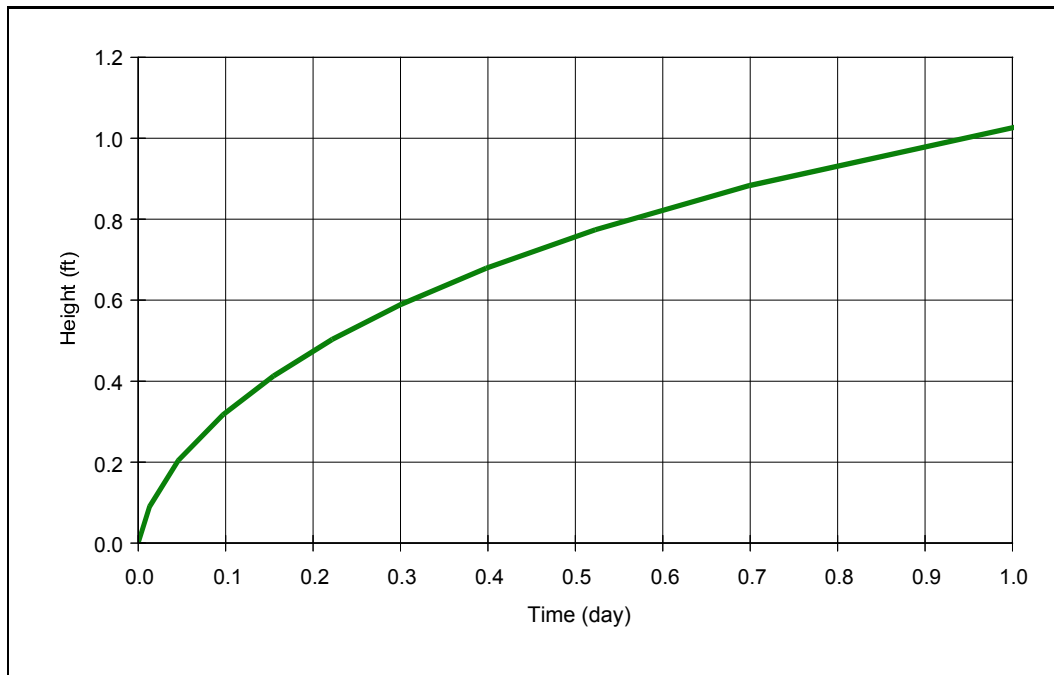
Y coordinate: 0 ft

Total volume applied: 2176.2 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.1
0	0.22
0.1	0.31
0.2	0.37
0.2	0.42
0.3	0.46
0.4	0.5
0.5	0.53
0.7	0.57
1	0.63

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: LC3 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:59:30 PM

INPUT PARAMETERS

Application rate: 3.78 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 172 ft

Width of application area: 11.33 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

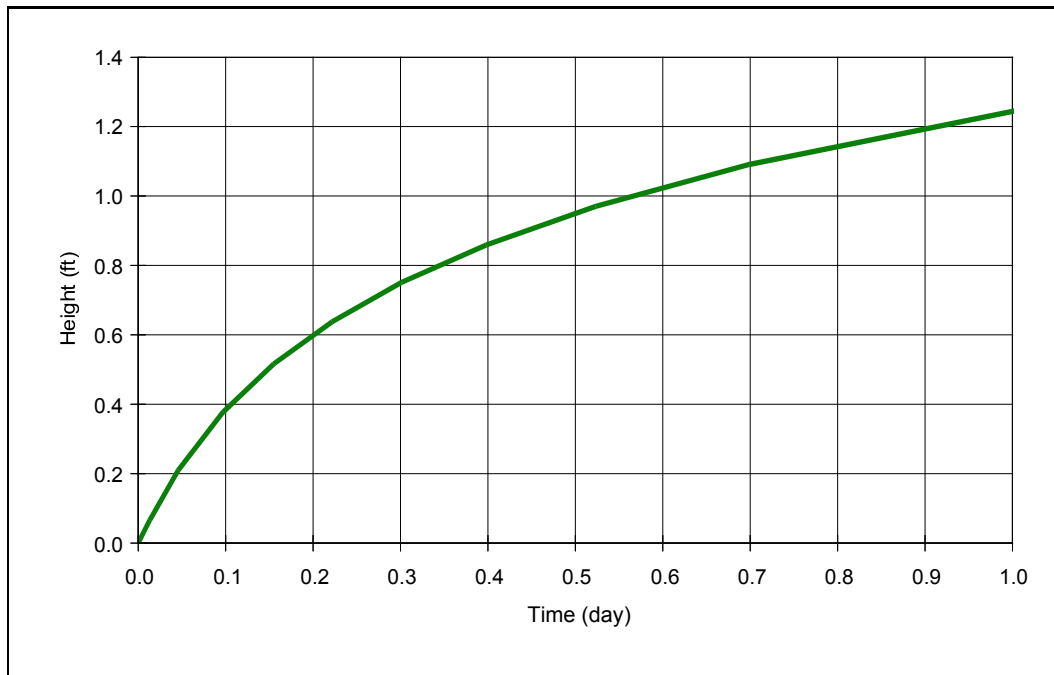
Y coordinate: 0 ft

Total volume applied: 7366.313 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.09
0	0.2
0.1	0.32
0.2	0.41
0.2	0.5
0.3	0.59
0.4	0.68
0.5	0.77
0.7	0.88
1	1.03

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: LC4 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 12:59:49 PM

INPUT PARAMETERS

Application rate: 1.78 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 9 ft/day

Initial saturated thickness: 20 ft

Length of application area: 35.5 ft

Width of application area: 16.5 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

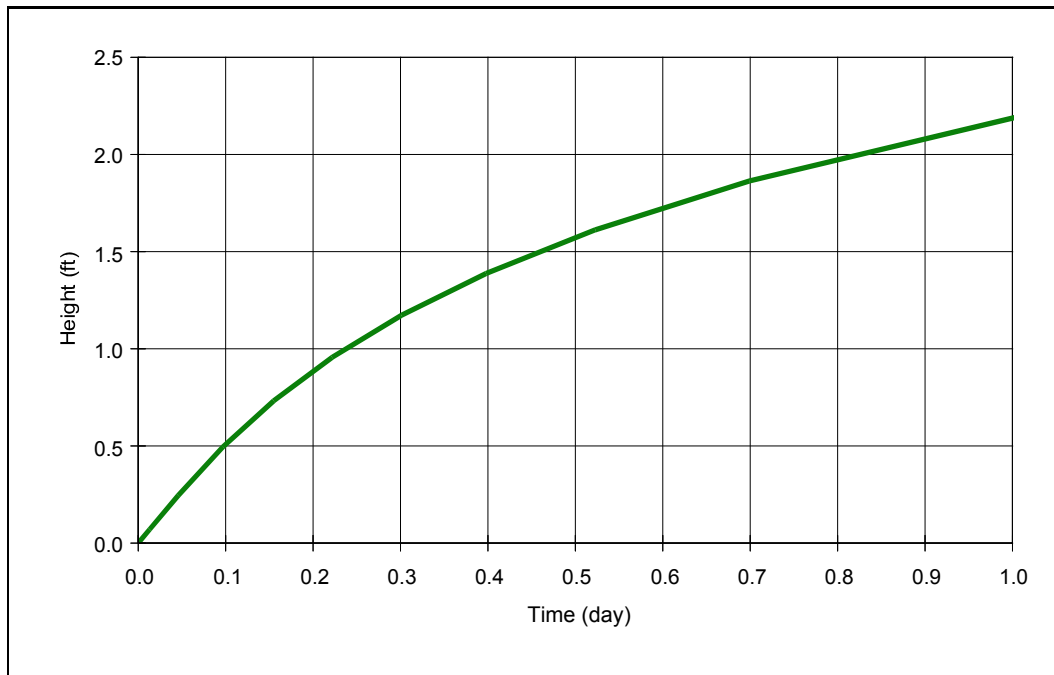
Y coordinate: 0 ft

Total volume applied: 1042.635 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.07
0	0.21
0.1	0.38
0.2	0.52
0.2	0.64
0.3	0.75
0.4	0.86
0.5	0.97
0.7	1.09
1	1.24

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: RAIN GARDEN 1 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 1:00:04 PM

INPUT PARAMETERS

Application rate: 1.89 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 8 ft

Length of application area: 65 ft

Width of application area: 50 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

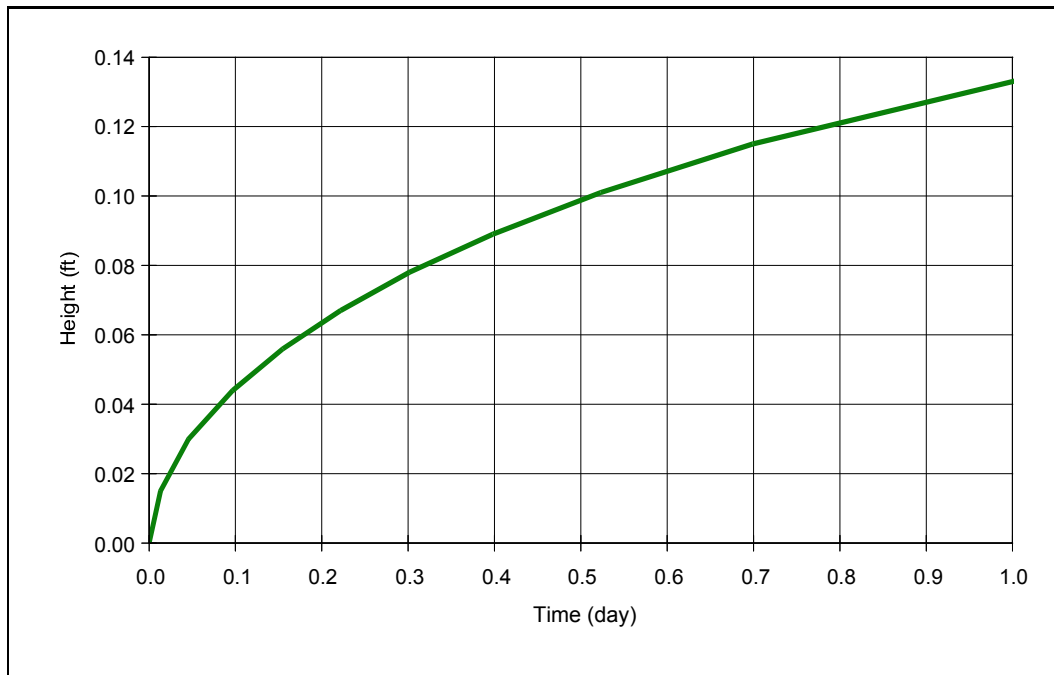
Y coordinate: 0 ft

Total volume applied: 6142.5 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.07
0	0.24
0.1	0.5
0.2	0.73
0.2	0.96
0.3	1.17
0.4	1.39
0.5	1.61
0.7	1.86
1	2.19

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: RAIN GARDEN 2 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 1:00:24 PM

INPUT PARAMETERS

Application rate: 1.77 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 180 ft

Width of application area: 3 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

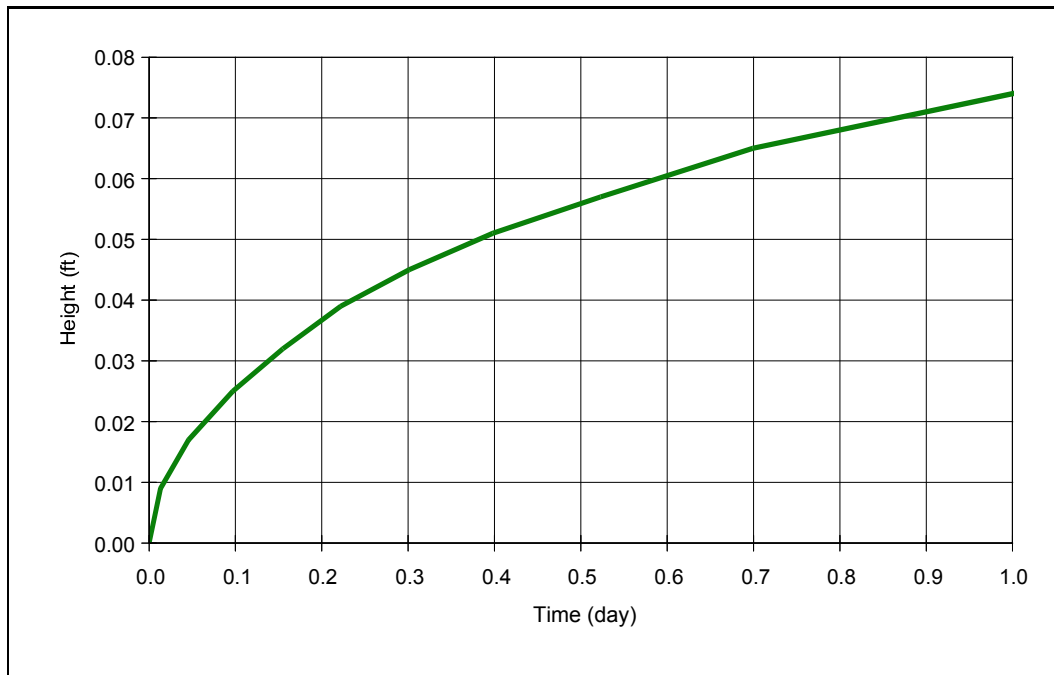
Y coordinate: 0 ft

Total volume applied: 955.8 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.02
0	0.03
0.1	0.04
0.2	0.06
0.2	0.07
0.3	0.08
0.4	0.09
0.5	0.1
0.7	0.12
1	0.13

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: RAIN GARDEN 3 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 1:00:39 PM

INPUT PARAMETERS

Application rate: 1.03 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 155 ft

Width of application area: 3 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

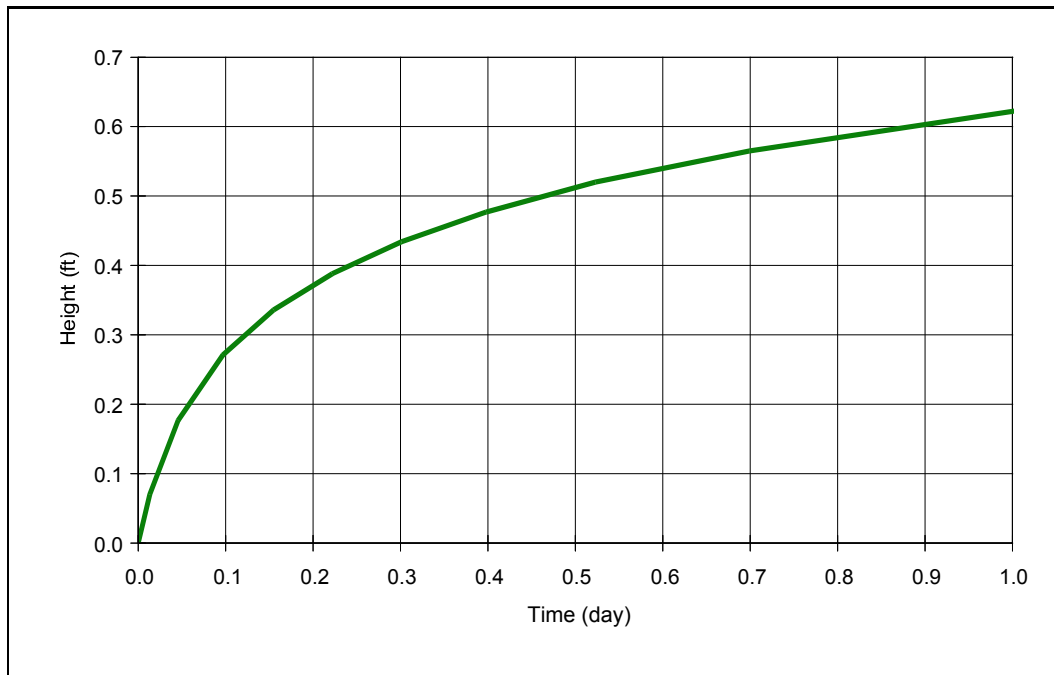
Y coordinate: 0 ft

Total volume applied: 478.95 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.01
0	0.02
0.1	0.02
0.2	0.03
0.2	0.04
0.3	0.04
0.4	0.05
0.5	0.06
0.7	0.06
1	0.07

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



COMPANY: OUTBACK ENGINEERING INC.

PROJECT: RAIN GARDEN 6 - TIMBERCREST

ANALYST: TOM MORRIS

DATE: 9/11/2017 TIME: 1:00:55 PM

INPUT PARAMETERS

Application rate: 2.03 c.ft/day/sq. ft

Duration of application: 1 day

Total simulation time: 1 day

Fillable porosity: 0.35

Hydraulic conductivity: 60 ft/day

Initial saturated thickness: 20 ft

Length of application area: 50 ft

Width of application area: 24 ft

No constant head boundary used

Groundwater mounding @

X coordinate: 0 ft

Y coordinate: 0 ft

Total volume applied: 2436 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
0	0.07
0	0.18
0.1	0.27
0.2	0.34
0.2	0.39
0.3	0.43
0.4	0.48
0.5	0.52
0.7	0.56
1	0.62