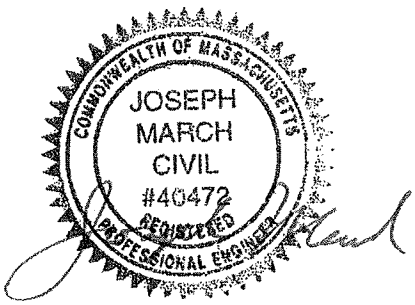
Stormwater Management Report

For

163 Hudson Street

Somerville, MA



November 16, 2010

Stamski And McNary, Inc.
Engineering - Planning – Surveying
1000 Main Street; Acton, MA 01720 (978) 263-8585
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SM-4729 File: 4729-StormwaterReportCover.doc

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NARRATIVE

The existing two-family residential dwelling located at #163 Hudson Street in Somerville contains 7,260 square feet of land. This lot has 82.50 feet of frontage along the public street to the south, with similar residential dwelling abutting to the east sideline and also to the west sideline along Hudson Street. Two residential dwellings on Albion Street also abut to the north along the rear lot line.

Presently the site contains a two-family colonial style dwelling with gutters and downspouts to daylight with a narrow side yard to the west. This side yard simply blends into the abutting side yard. A sloping concrete driveway is present along the east side of the dwelling from the sidewalk in Hudson Street down to a detached concrete slab behind the dwelling which is used as off-street parking for two automobiles. This concrete slab has a leaning block retaining wall along the rear lot line and flush block walls on both sides adjacent to the lawn areas. A concrete patio exists beneath the deck and rear of the dwelling between the driveway and dwelling which provides access to a cellar door and to the steps up to a deck and rear door of the dwelling. Runoff from the roof currently drains down each side of the dwelling onto the lawn prior to the rear lot line. The concrete pad beneath the deck drains to the left of the concrete slab onto the lawn while the concrete driveway drains to the right of the concrete slab onto the lawn prior to the rear lot line.

The remainder of the eastern side yard is lawn with typical mature trees. Along the eastern lot line, since the abutting dwelling is higher in elevation, measures have been taken to maintain the slope, such as an existing rip rap slope, raised railroad tie planter bed and block retaining wall with stockade fence which supports the abutters patio behind the walkout basement in the rear of the abutting dwelling.

In the front yard of the site is an existing walkway to the front door and the lawn adjacent to the dwelling is surrounded by a raised concrete edging. Various types and segments of fences are present along the front, rear and side yards of this lot.

Runoff from the sidewalks and pavement in Hudson Street remains in Hudson Street and is collected by the existing catch basins and carried away from the front of the site. Runoff from this lot and the abutting lots between Hudson Street and Albion Street currently sheet flows in a northerly direction between the abutting dwellings and into the Albion Street drainage system which is down gradient.

A soil test pit (TP-A) was conducted on November 4, 2010 and a site walk was conducted with the direct abutters to the east and west to discuss existing runoff conditions and concerns. The test pit was conducted to determine on-site soil characteristics at the proposed drywell location indicated on the approved Site Plan.

Top soil and general fill material was discovered to a depth of three (3) feet, over a compact glacial till which was observed to a depth of over nine (9) feet. No standing groundwater or weeping was observed. Soil mottling was observed within this glacial till at a depth of four (4') feet, however groundwater may no longer reach this height, due to the dense development within this area, and close location of the city drainage system which carries runoff away from the area uphill. Based on existing conditions, reliance on this relic mottling may not provide an accurate estimate of seasonal high groundwater, since runoff is being carried away prior to reaching the site. Therefore, current high groundwater conditions at this site may be lower than indicated by the relic mottling observed within the test pit, and such consideration may be necessary in this and in future designs.

This soil type combined with the existing slope of topography within this site results in a larger percentage of a storm event being runoff as opposed to infiltrating on-site due to the slower rate of water transmission into the soil layer. This slower rate of transmission has been confirmed on-site during our soil testing and a lower value of permeability has been selected in our drainage design and analysis.

Pre-Development Drainage Areas:

This site has one main hydrologic subcatchment area under pre-development conditions which drains to the rear lot prior to ultimately reaching the Albion Street drainage system down hill. The time of concentration (Tc) for this subcatchment was calculated by estimating the longest (hydrologic) path rainfall would travel from the outer reach of the drainage area to the corresponding point of analysis.

Existing Subcatchments

1 – Rear Lot Line	0.167 acres (7,620 s.f.)
Total	**0.167 acres (7,620 s.f.)**

Subcatchment 1, consisting of approximately 0.167 acres, which is the entire site. The site drains from front to back. The drainage area is made up of the dwelling (1,209 s.f.), walkways, concrete driveway, pad and concrete slab area (1,467 s.f.), with the remainder of the site primarily lawn and open space (4,584 s.f.). Gutters and downspouts direct roof runoff to daylight towards the rear lawn area directly behind the dwelling. Driveway runoff is also directed towards the rear lawn area directly adjacent to the driveway. All runoff currently sheet flows across the vegetated lawn across the rear fenced lot line ultimately draining into the Albion Street drainage system following traveling over side yards of abutting dwelling on Albion Street.

Post-Development Drainage Areas:

The owner has obtained approval to construct a 600± square foot addition to the east of the dwelling towards the rear yard. A new two-car garage under will be provided under the addition and the proposed first floor of the addition will match the existing first floor elevation. The driveway curb cut will be relocated to the east and a new access driveway will be provided to a proposed turnout area in front of the two garage doors and two exterior parking areas. The turnout area will be constructed of permeable pavers and a roof drywell has been provided to offset the increase in the peak rate and volume of runoff due to development in accordance with the approved Site Plan. All disturbed areas shall receive 6" of loam and seed. Additional mature trees and shrubs will be provided per the Decision.

Proposed Subcatchments

1A – To Rear Lot line	0.143 acres
1B – To Roof Drywell	0.024 acres
Total	**0.167 acres**

Subcatchment 1A, consisting of approximately 0.143 acres, which is the entire site minus the flat roof area shown on the Site Plan to be directed to the proposed roof drywell. The site will continue to drain from front to back. The drainage area is made up of the front higher roof of the dwelling (731 s.f.), new walkways, parking spaces, relocated access driveway, pavement edging (1,393 s.f.), and permeable pavers (786 s.f.) with the remainder of the site primarily lawn and open space (3,308 s.f.). Gutters and downspouts from the higher front roof will continue to drain to daylight towards the rear lawn areas. The parking spaces have been regraded to direct runoff towards the rear lawn area. The access driveway runoff will continue to sheet flow across the vegetated lawn across the rear fenced lot line or into the permeable paved area in front of the garage doors.

It is recommended that this permeable parking area be designed and installed in accordance with the Interlocking Concrete Pavement Institute (ICPI) standards and specifications for Permeable Interlocking Concrete Pavement subject to vehicular loading. A railing and fence should also be provided along the edge of parking area and driveway turnout along the rear lot line. All runoff will continue, similar to existing conditions to ultimately drain into the Albion Street drainage system following travel over side yards of abutting dwellings on Albion Street.

Existing top soil and fill material will be removed beneath and within five feet of the permeable paver area and replaced with clean sand.

Subcatchment 1B, consists of approximately 0.024 acres of impervious roof area, which is the area shown as the proposed flat roof (1,024 s.f.) on the Site Plan. A central roof drain will be provided by the builder to collect and direct this flat roof runoff into the proposed drywell from beneath the basement floor of the Addition.

The drywell design, elevation and location is based on the specific site features which include the soil type, estimated depth to groundwater and proposed grading, including the aggregate base of the permeable pavement area.

All runoff exceeding the storage capacity of the drywell will combine with runoff which flows directly to the rear lot line beneath the permeable paved area. The top of drywell is proposed beneath the existing basement floor elevation of the Addition and below the aggregate base of the permeable pavers.

The following table summarizes the pre and post development peak rates and volumes of runoff for the respective points of analysis:

	2-Year Storm		**10-Year Storm**		**100-Year Storm**	
Point of Analysis	**Pre (cfs)**	**Post (cfs)**	**Pre (cfs)**	**Post (cfs)**	**Pre (cfs)**	**Post (cfs)**
Rear Lot Line	0.303	0.270	0.530	0.466	0.864	0.753
	Pre-Volume (cf)	**Post-Volume (cf)**	**Pre-Volume (cf)**	**Post-Volume (cf)**	**Pre-Volume (cf)**	**Post-Volume (cf)**
Rear Lot Line	906	808	1,589	1,401	2,631	2,416

Detailed calculations are attached.

DESIGN BASIS

1. The United States Soil Conversation Service TR55 Methodology was used to determine off-site rates of runoff.

4. The twenty-four hour rainfall from the Soil Conversation Service (SCS) publications is 6.6 inches for the 100-year storm, 4.6 inches for the 10-year storm, and 3.2 inches for the two-year storm event.

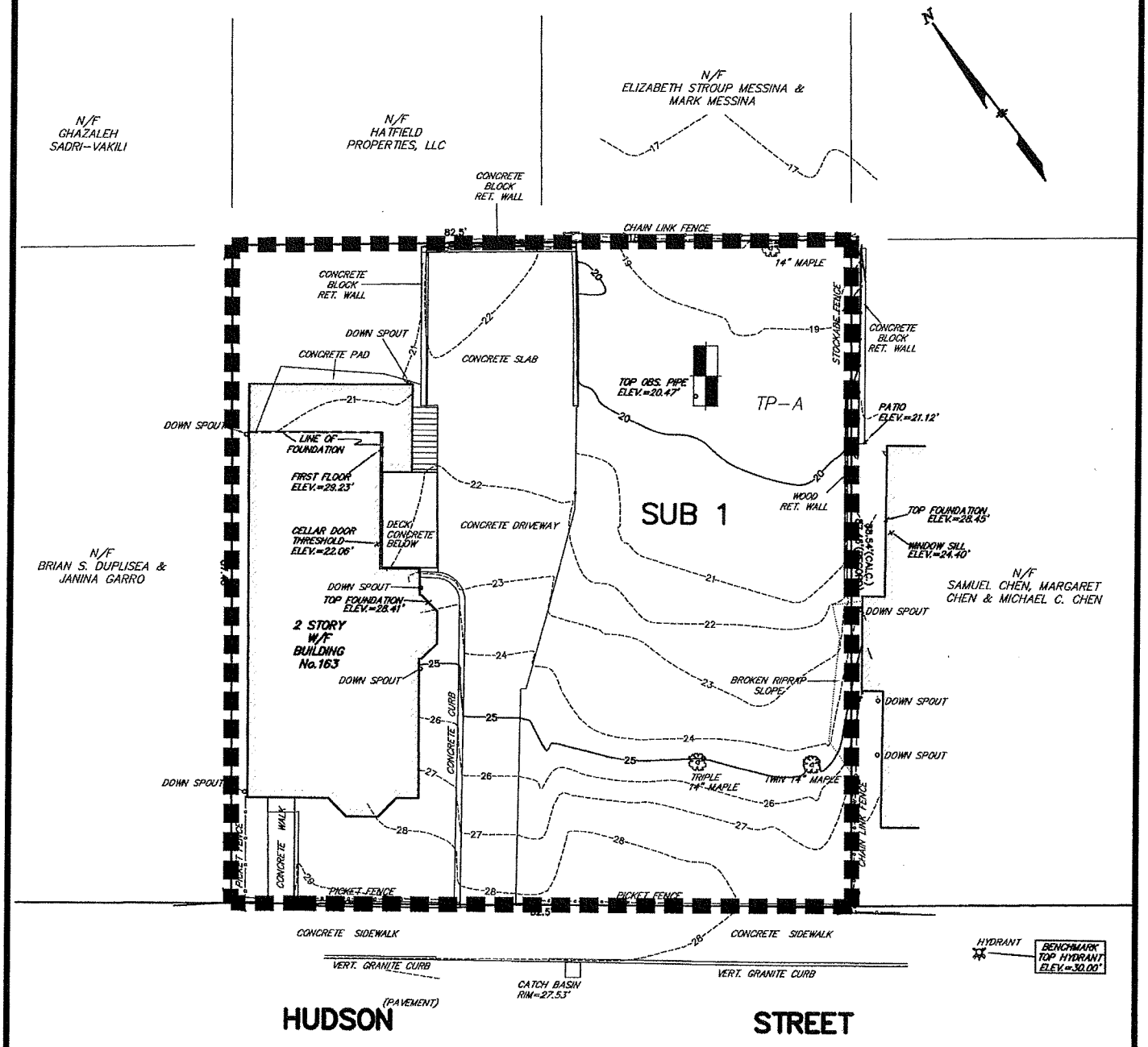
5. The hydraulic calculations were performed using the computer program: Hydraflow™ Hydrographs for Windows, Version 2007, by Intelisolve.

6. The soil types of the site were taken from the Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.ncrs.usda.gov.

7. Soil type description obtained from Middlesex County Inerim Soil Survey Report.

8. Permeability Rate obtained from Table 2-1 Hydrologic Soil Properties Classified by Soil Texture; Source Rawls, Brakensiek and Saxton, 1982

9. The saturated permeability of 0.52 in./hr. was used for an infiltration rate at the Proposed Drywell. It is a lower rate for a loam which was observed on-site within a test pit dug by Stamski and McNary, Inc. This selected rate as concurs with the lower range for permeability for Newport Soil within the Middlesex Soil Survey Report.



EXISTING DRAINAGE PLAN

FOR: GOGUEN

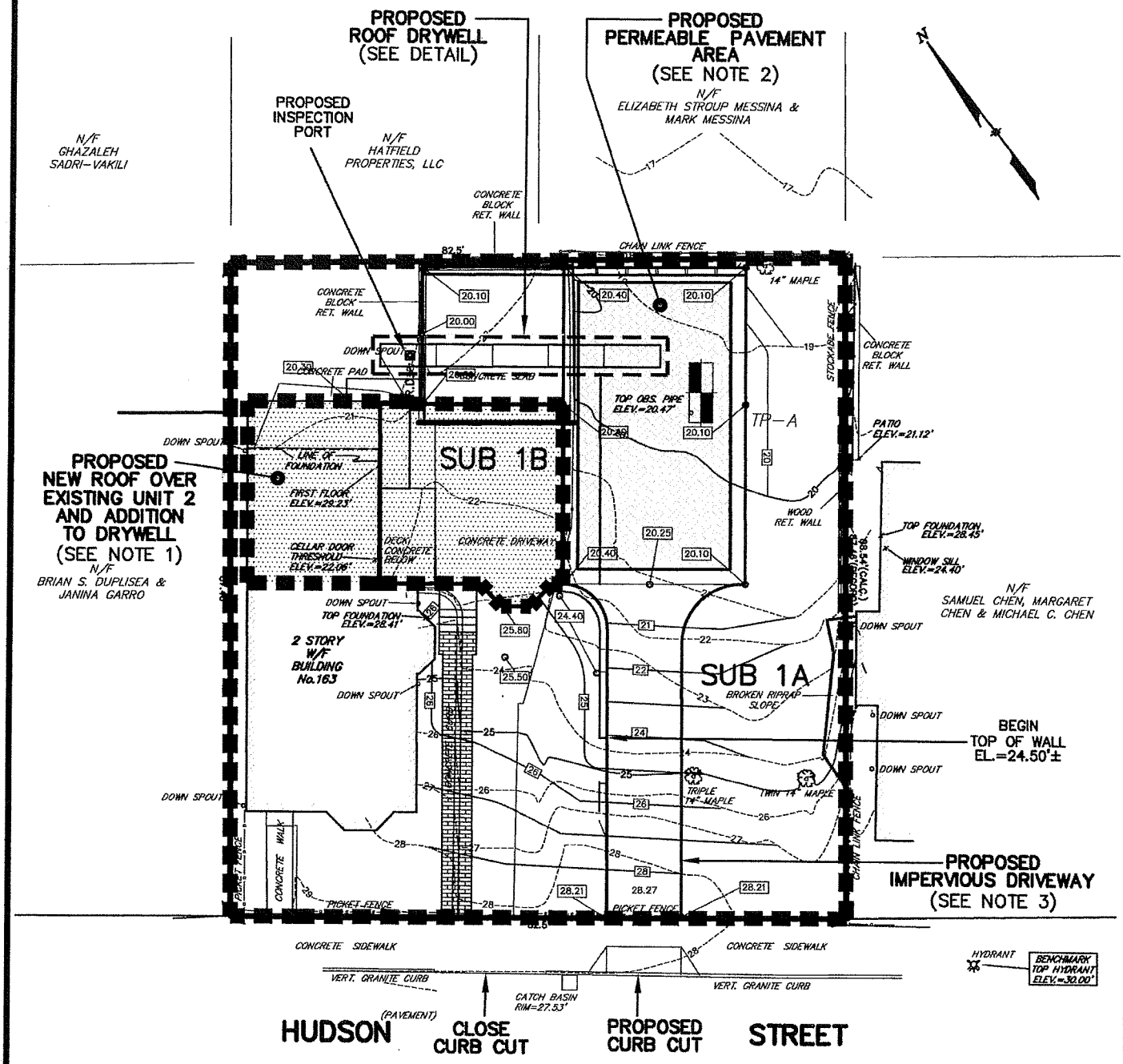
SCALE: 1"=20' NOV. 15, 2010

STAMSKI AND MCNARY, INC.

1000 MAIN STREET ACTON, MASSACHUSETTS

ENGINEERING - PLANNING - SURVEYING

(4729WORKSITE.dwg) HUDSON STREET SM-4729



PROPOSED DRAINAGE PLAN

FOR: GOGUEN

SCALE: 1"=20' NOV. 15, 2010

STAMSKI AND MCNARY, INC.

1000 MAIN STREET ACTON, MASSACHUSETTS

ENGINEERING – PLANNING – SURVEYING

(4729WORKSITE.dwg) HUDSON STREET SM-4729

NOTES:

1. INTERNAL ROOF DRAIN TO BE CENTRALLY LOCATED WITHIN FLAT ROOF AREA WHICH WILL EXIT FROM ADDITION UNDER REAR OF SLAB FOUNDATION TO PROPOSED DRYWELL.
2. DESIGN OF PERMEABLE PAVEMENT AREA TO BE PROVIDED BY OTHERS.
3. GRADES OF PROPOSED DRIVEWAY ACCESS IS BASED ON ELEVATIONS OF EXISTING TOP OF FOUNDATION, PROPOSED ADDITION AND SIDEWALK GRADE AND ARE SUBJECT TO MINOR ADJUSTMENTS.

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	0.303	2	724	906	----	------	------	Sub. 1 - To Rear Lot Line
3	SCS Runoff	0.270	2	724	808	----	------	------	Sub. 1A - To Rear Lot Line
4	SCS Runoff	0.072	2	724	242	----	------	------	Sub. 1B - To Roof Drywell
5	Reservoir	0.000	2	1824	0	4	17.64	124	Roof Drywell
6	Combine	0.270	2	724	808	3, 5	------	------	Total to Rear Lot Line

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	0.530	2	724	1,589	----	------	------	Sub. 1 - To Rear Lot Line
3	SCS Runoff	0.466	2	724	1,401	----	------	------	Sub. 1A - To Rear Lot Line
4	SCS Runoff	0.104	2	724	356	----	------	------	Sub. 1B - To Roof Drywell
5	Reservoir	0.000	2	394	0	4	18.43	200	Roof Drywell
6	Combine	0.466	2	724	1,401	3, 5	------	------	Total to Rear Lot Line

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	0.864	2	724	2,631	----	------	------	Sub. 1 - To Rear Lot Line
3	SCS Runoff	0.753	2	724	2,301	----	------	------	Sub. 1A - To Rear Lot Line
4	SCS Runoff	0.150	2	724	520	----	------	------	Sub. 1B - To Roof Drywell
5	Reservoir	0.150	2	730	115	4	18.62	210	Roof Drywell
6	Combine	0.753	2	724	2,416	3, 5	------	------	Total to Rear Lot Line

PRE-DEVELOPMENT HYDROLOGY

Worksheet 2: Runoff curve number and runoff **SM-4729**

Project: 163 Hudson Street By RJH Date 11/15/10

Location: 163 Hudson Street Somerville MA Checked _____ Date _____

Circle one: [Present] Developed Rear Lot Line

1. Runoff curve number (CN)

Soil name and hydrologic soil group (appendix A)	Cover description (cover type, treatment, and hydrologic condition: percent impervious: unconnected/connected impervious area ratio)		CN Table 2-2	CN Fig. 2-3	CN Fig. 2-4	Area Acres	Product of CN x Area
C	Open Space (Good Condition)	4584	74			0.105	7.79
C	Impervious (Roof)	1209	98			0.028	2.72
C	Impervious (Driveway & Walkways)	1467	98			0.034	3.30
		7260			Totals =	0.167	13.81

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{13.81}{0.17} = 82.85$; Use CN = [82.8]

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency.....	yr	2	10	100
Rainfall, P (24-hour).....	in	3.2	4.6	6.6
Runoff, Q..... (Use P and CN with table 2-1, fig. 2-1,) or eqs. 2-3 and 2-4.)	in	1.60	2.80	4.63
Runoff, Q.....	cf	967	1694	2804

(210-VI-TR-55, Second Ed., June 1986)

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 1

Sub. 1 - To Rear Lot Line

Hydrograph type	= SCS Runoff	Peak discharge	= 0.303 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,631 cuft
Drainage area	= 0.167 ac	Curve number	= 82.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 3.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time -- Outflow (hrs	cfs)
11.77	0.066
11.80	0.074
11.83	0.083
11.87	0.093
11.90	0.103
11.93	0.120
11.97	0.156
12.00	0.215
12.03	0.277
12.07	0.303 <<
12.10	0.277
12.13	0.224
12.17	0.177
12.20	0.151
12.23	0.138
12.27	0.130
12.30	0.121
12.33	0.112
12.37	0.102
12.40	0.092
12.43	0.083
12.47	0.072
12.50	0.062

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 1

Sub. 1 - To Rear Lot Line

Hydrograph type	= SCS Runoff	Peak discharge	= 0.530 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,631 cuft
Drainage area	= 0.167 ac	Curve number	= 82.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 4.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time -- Outflow (hrs	cfs)
11.73	0.113
11.77	0.128
11.80	0.143
11.83	0.159
11.87	0.176
11.90	0.193
11.93	0.222
11.97	0.285
12.00	0.387
12.03	0.492
12.07	0.530 <<
12.10	0.480
12.13	0.384
12.17	0.301
12.20	0.255
12.23	0.233
12.27	0.217
12.30	0.202
12.33	0.186
12.37	0.170
12.40	0.153
12.43	0.136
12.47	0.119

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 1

Sub. 1 - To Rear Lot Line

Hydrograph type	= SCS Runoff	Peak discharge	= 0.864 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,631 cuft
Drainage area	= 0.167 ac	Curve number	= 82.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 6.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)
11.70	0.176
11.73	0.200
11.77	0.225
11.80	0.250
11.83	0.276
11.87	0.303
11.90	0.330
11.93	0.376
11.97	0.477
12.00	0.643
12.03	0.809
12.07	0.864 <<
12.10	0.776
12.13	0.617
12.17	0.481
12.20	0.406
12.23	0.369
12.27	0.343
12.30	0.318
12.33	0.292
12.37	0.266
12.40	0.240
12.43	0.214
12.47	0.187

...End

POST-DEVELOPMENT HYDROLOGY

Worksheet 2: Runoff curve number and runoff SM-4729

Project: 163 Hudson Street By RJH Date 11/15/10

Location: 163 Hudson Street Somerville MA Checked _____ Date _____

Circle one: Present [Developed] Direct to Rear Lot Line

1. Runoff curve number (CN)

Soil name and hydrologic soil group (appendix	Cover description (cover type, treatment, and hydrologic condition: percent impervious: unconnected/connected impervious area ratio)		CN Table 2-2	CN Fig. 2-3	CN Fig. 2-4	Area Acres	Product of CN x Area
C	Open Space (Good Condition)	3308	74			0.076	5.62
C	Permeable Driveway (Paver Area) *CN = (98+74)/2 = 86	786	*	86		0.018	1.55
C	Impervious (Roof)	731	98			0.017	1.64
C	Impervious (~~Roof~~, Driveway & Walkways)	1393	98			0.032	3.13
		6218 sf			Totals =	0.143	11.95
1/ Use only one CN source per line.		0.143 Ac.					

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{11.95}{0.14} = 83.72$; Use CN = [83.7]

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency.....	yr	2	10	100
Rainfall, P (24-hour).....	in	3.2	4.6	6.6
Runoff, Q..... (Use P and CN with table 2-1, fig. 2-1,) or eqs. 2-3 and 2-4.)	in			
Runoff, Q.....	cf			

D-2 (210-VI-TR-55, Second Ed., June 1986)

Worksheet 2: Runoff curve number and runoff SM-4729

Project: 163 Hudson Street By RJH Date 11/15/10

Location: 163 Hudson Street Somerville MA Checked _____ Date _____

Circle one: Present [Developed] To Roof Drywell

1. Runoff curve number (CN)

Soil name and hydrologic soil group (appendix A)	Cover description (cover type, treatment, and hydrologic condition: percent impervious: unconnected/connected impervious area ratio)		CN Table 2-2	CN Fig. 2-3	CN Fig. 2-4	Area Acres	Product of CN x Area
C	Open Space (Good Condition)	0	74			0.000	0.00
C	Impervious (Roof Area of Addition)	1042	98			0.024	2.34
C	Pervious Paver Area (Driveway Area)	0	98			0.000	0.00
					Totals =	0.024	2.34

1042 sf
0.024 Ac.

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{2.34}{0.02} = 98.00$; Use CN = [98.0]

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency.....	yr	2	10	100
Rainfall, P (24-hour).....	in	3.2	4.6	6.6
Runoff, Q..... (Use P and CN with table 2-1, fig. 2-1,) or eqs. 2-3 and 2-4.)	in			
Runoff, Q.....	cf			

D-2 (210-VI-TR-55, Second Ed., June 1986)

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 3

Sub. 1A - To Rear Lot Line

Hydrograph type	= SCS Runoff	Peak discharge	= 0.270 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,301 cuft
Drainage area	= 0.143 ac	Curve number	= 83.7
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 3.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)
11.77	0.060
11.80	0.068
11.83	0.076
11.87	0.084
11.90	0.094
11.93	0.108
11.97	0.140
12.00	0.193
12.03	0.248
12.07	0.270 <<
12.10	0.247
12.13	0.199
12.17	0.157
12.20	0.134
12.23	0.122
12.27	0.115
12.30	0.107
12.33	0.099
12.37	0.090
12.40	0.082
12.43	0.073
12.47	0.064
12.50	0.055

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 4

Sub. 1B - To Roof Drywell

Hydrograph type	= SCS Runoff	Peak discharge	= 0.072 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 520 cuft
Drainage area	= 0.024 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 3.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)
11.67	0.015
11.70	0.017
11.73	0.019
11.77	0.021
11.80	0.023
11.83	0.025
11.87	0.028
11.90	0.030
11.93	0.033
11.97	0.042
12.00	0.055
12.03	0.068
12.07	0.072 <<
12.10	0.064
12.13	0.050
12.17	0.039
12.20	0.032
12.23	0.029
12.27	0.027
12.30	0.025
12.33	0.023
12.37	0.021
12.40	0.019
12.43	0.017
12.47	0.015

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 5

Roof Drywell

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= 30.40 hrs
Time interval	= 2 min	Hyd. volume	= 115 cuft
Inflow hyd. No.	= 4 - Sub. 1B - To Roof Drywell	Reservoir name	= Roof Drywell
Max. Elevation	= 17.64 ft	Max. Storage	= 124 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
30.40	0.000	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 6

Total to Rear Lot Line

Hydrograph type	= Combine	Peak discharge	= 0.270 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,416 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.143 ac

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Hyd. 3 + (cfs)	Hyd. 5 = (cfs)	Outflow (cfs)
11.77	0.060	0.000	0.060
11.80	0.068	0.000	0.068
11.83	0.076	0.000	0.076
11.87	0.084	0.000	0.084
11.90	0.094	0.000	0.094
11.93	0.108	0.000	0.108
11.97	0.140	0.000	0.140
12.00	0.193	0.000	0.193
12.03	0.248	0.000	0.248
12.07	0.270 <<	0.000	0.270 <<
12.10	0.247	0.000	0.247
12.13	0.199	0.000	0.199
12.17	0.157	0.000	0.157
12.20	0.134	0.000	0.134
12.23	0.122	0.000	0.122
12.27	0.115	0.000	0.115
12.30	0.107	0.000	0.107
12.33	0.099	0.000	0.099
12.37	0.090	0.000	0.090
12.40	0.082	0.000	0.082
12.43	0.073	0.000	0.073
12.47	0.064	0.000	0.064
12.50	0.055	0.000	0.055

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 3

Sub. 1A - To Rear Lot Line

Hydrograph type	= SCS Runoff	Peak discharge	= 0.466 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,301 cuft
Drainage area	= 0.143 ac	Curve number	= 83.7
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 4.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)
11.73	0.101
11.77	0.114
11.80	0.128
11.83	0.142
11.87	0.157
11.90	0.172
11.93	0.197
11.97	0.252
12.00	0.342
12.03	0.433
12.07	0.466 <<
12.10	0.421
12.13	0.337
12.17	0.264
12.20	0.223
12.23	0.203
12.27	0.190
12.30	0.176
12.33	0.162
12.37	0.148
12.40	0.134
12.43	0.119
12.47	0.104

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 4

Sub. 1B - To Roof Drywell

Hydrograph type	= SCS Runoff	Peak discharge	= 0.104 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 520 cuft
Drainage area	= 0.024 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 4.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)
11.67	0.022
11.70	0.025
11.73	0.028
11.77	0.031
11.80	0.034
11.83	0.037
11.87	0.040
11.90	0.043
11.93	0.048
11.97	0.060
12.00	0.080
12.03	0.099
12.07	0.104 <<
12.10	0.092
12.13	0.072
12.17	0.056
12.20	0.047
12.23	0.042
12.27	0.039
12.30	0.036
12.33	0.033
12.37	0.030
12.40	0.027
12.43	0.024
12.47	0.021

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 5

Roof Drywell

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 6.57 hrs
Time interval	= 2 min	Hyd. volume	= 115 cuft
Inflow hyd. No.	= 4 - Sub. 1B - To Roof Drywell	Reservoir name	= Roof Drywell
Max. Elevation	= 18.43 ft	Max. Storage	= 200 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
6.57	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<
6.67	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<
6.90	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<
7.00	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<
7.07	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<
7.37	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<
7.47	0.002	18.55 <<	-----	-----	-----	-----	-----	-----	-----	-----	0.004	0.000 <<

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 6

Total to Rear Lot Line

Hydrograph type	= Combine	Peak discharge	= 0.466 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,416 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.143 ac

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Hyd. 3 + (cfs)	Hyd. 5 = (cfs)	Outflow (cfs)
11.73	0.101	0.000	0.101
11.77	0.114	0.000	0.114
11.80	0.128	0.000	0.128
11.83	0.142	0.000	0.142
11.87	0.157	0.000	0.157
11.90	0.172	0.000	0.172
11.93	0.197	0.000	0.197
11.97	0.252	0.000	0.252
12.00	0.342	0.000	0.342
12.03	0.433	0.000	0.433
12.07	0.466 <<	0.000	0.466 <<
12.10	0.421	0.000	0.421
12.13	0.337	0.000	0.337
12.17	0.264	0.000	0.264
12.20	0.223	0.000	0.223
12.23	0.203	0.000	0.203
12.27	0.190	0.000	0.190
12.30	0.176	0.000	0.176
12.33	0.162	0.000	0.162
12.37	0.148	0.000	0.148
12.40	0.134	0.000	0.134
12.43	0.119	0.000	0.119
12.47	0.104	0.000	0.104

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 3

Sub. 1A - To Rear Lot Line

Hydrograph type	= SCS Runoff	Peak discharge	= 0.753 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,301 cuft
Drainage area	= 0.143 ac	Curve number	= 83.7
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 6.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)	
11.70	0.156	
11.73	0.176	
11.77	0.198	
11.80	0.220	
11.83	0.243	
11.87	0.266	
11.90	0.290	
11.93	0.329	
11.97	0.418	
12.00	0.562	
12.03	0.706	
12.07	0.753	<<
12.10	0.675	
12.13	0.536	
12.17	0.418	
12.20	0.352	
12.23	0.320	
12.27	0.298	
12.30	0.276	
12.33	0.253	
12.37	0.231	
12.40	0.208	
12.43	0.185	
12.47	0.162	

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 4

Sub. 1B - To Roof Drywell

Hydrograph type	= SCS Runoff	Peak discharge	= 0.150 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 520 cuft
Drainage area	= 0.024 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.0 min
Total precip.	= 6.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Outflow (cfs)
11.67	0.031
11.70	0.036
11.73	0.040
11.77	0.045
11.80	0.049
11.83	0.053
11.87	0.058
11.90	0.062
11.93	0.070
11.97	0.087
12.00	0.115
12.03	0.142
12.07	0.150 <<
12.10	0.133
12.13	0.104
12.17	0.080
12.20	0.067
12.23	0.061
12.27	0.056
12.30	0.052
12.33	0.048
12.37	0.043
12.40	0.039
12.43	0.035
12.47	0.030

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 5

Roof Drywell

Hydrograph type	= Reservoir	Peak discharge	= 0.150 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 115 cuft
Inflow hyd. No.	= 4 - Sub. 1B - To Roof Drywell	Reservoir name	= Roof Drywell
Max. Elevation	= 18.62 ft	Max. Storage	= 210 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
12.17	0.080	18.56 <<	-----	-----	-----	-----	0.150	-----	-----	-----	0.004	0.150 <<
12.23	0.061	18.56	-----	-----	-----	-----	0.106	-----	-----	-----	0.004	0.106
12.30	0.052	18.56	-----	-----	-----	-----	0.081	-----	-----	-----	0.004	0.081
12.37	0.043	18.55	-----	-----	-----	-----	0.062	-----	-----	-----	0.004	0.062
12.43	0.035	18.55	-----	-----	-----	-----	0.046	-----	-----	-----	0.004	0.046
12.50	0.026	18.55	-----	-----	-----	-----	0.032	-----	-----	-----	0.004	0.032

...End

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Hyd. No. 6

Total to Rear Lot Line

Hydrograph type	= Combine	Peak discharge	= 0.753 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,416 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.143 ac

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Hyd. 3 + (cfs)	Hyd. 5 = (cfs)	Outflow (cfs)
11.70	0.156	0.000	0.156
11.73	0.176	0.000	0.176
11.77	0.198	0.000	0.198
11.80	0.220	0.000	0.220
11.83	0.243	0.000	0.243
11.87	0.266	0.000	0.266
11.90	0.290	0.000	0.290
11.93	0.329	0.000	0.329
11.97	0.418	0.000	0.418
12.00	0.562	0.000	0.562
12.03	0.706	0.000	0.706
12.07	0.753 <<	0.000	0.753 <<
12.10	0.675	0.000	0.675
12.13	0.536	0.000	0.536
12.17	0.418	0.150 <<	0.568
12.20	0.352	0.004	0.357
12.23	0.320	0.106	0.426
12.27	0.298	0.013	0.310
12.30	0.276	0.081	0.357
12.33	0.253	0.017	0.270
12.37	0.231	0.062	0.292
12.40	0.208	0.017	0.225
12.43	0.185	0.046	0.231
12.47	0.162	0.014	0.176
12.50	0.139	0.032	0.170

...End

Pond Report

Hydraflow Hydrographs by Intelisolve v9.2 — Monday, Nov 15, 2010

Pond No. 2 - Roof Drywell

Pond Data

UG Chambers - Invert elev. = 17.00 ft, Rise x Span = 1.04 x 3.00 ft, Barrel Len = 37.50 ft, No. Barrels = 1, Slope = 0.00%, Headers = No
Encasement - Invert elev. = 16.50 ft, Width = 5.00 ft, Height = 5.00 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	16.50	n/a	0	0
0.50	17.00	n/a	38	38
1.00	17.50	n/a	70	107
1.50	18.00	n/a	60	167
2.00	18.50	n/a	38	205
2.50	19.00	n/a	38	243
3.00	19.50	n/a	38	280
3.50	20.00	n/a	38	318
4.00	20.50	n/a	38	355
4.50	21.00	n/a	38	393
5.00	21.50	n/a	38	430

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 17.00	0.00	0.00	0.00
Crest El. (ft)	= 18.55	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.520 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	16.50	---	---	---	---	0.00	---	---	---	0.000	---	0.000
0.05	4	16.55	---	---	---	---	0.00	---	---	---	0.002	---	0.002
0.10	8	16.60	---	---	---	---	0.00	---	---	---	0.002	---	0.002
0.15	11	16.65	---	---	---	---	0.00	---	---	---	0.002	---	0.002
0.20	15	16.70	---	---	---	---	0.00	---	---	---	0.002	---	0.002
0.25	19	16.75	---	---	---	---	0.00	---	---	---	0.002	---	0.002
0.30	23	16.80	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.35	26	16.85	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.40	30	16.90	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.45	34	16.95	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.50	38	17.00	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.55	44	17.05	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.60	51	17.10	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.65	58	17.15	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.70	65	17.20	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.75	72	17.25	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.80	79	17.30	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.85	86	17.35	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.90	93	17.40	---	---	---	---	0.00	---	---	---	0.003	---	0.003
0.95	100	17.45	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.00	107	17.50	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.05	113	17.55	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.10	119	17.60	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.15	125	17.65	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.20	131	17.70	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.25	137	17.75	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.30	143	17.80	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.35	149	17.85	---	---	---	---	0.00	---	---	---	0.003	---	0.003
1.40	155	17.90	---	---	---	---	0.00	---	---	---	0.004	---	0.004
1.45	161	17.95	---	---	---	---	0.00	---	---	---	0.004	---	0.004

Continues on next page...

SOIL INFORMATION

Soil Map from USDA NRCS
For Newport-Urban land Complex, 0 to 8 percent slopes

Table 2-1 By Rawls, Brakensiek and sexton, 1982

Middlesex County Interim Soil Survey Report
Newport Soil Type - Definition
Permeability - Definition
Table B. Newport Soil Permeability Range

Soil Observation Log (Test Pit A)
Conducted by Stamski and McNary, Inc.

Soil Map—Middlesex County, Massachusetts
(Hudson St)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:1,780 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:25,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 12, Feb 26, 2010

Date(s) aerial images were photographed: 7/10/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
621B	Scio-Urban land complex, 0 to 8 percent slopes	B	2.1	33.2%
627C	Newport-Urban land complex, 3 to 15 percent slopes	C	4.3	66.8%
Totals for Area of Interest			6.4	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

TABLE 2-1 HYDROLOGIC SOIL PROPERTIES CLASSIFIED BY SOIL TEXTURE*

Texture Class	Effective Water Capacity (C_w) porosity	Minimum Infiltration Rate (f) in/hr	Hydrologic Soil Grouping
Sand	0.35	8.27	A
Loamy Sand	0.31	2.41	A
Sandy Loam	0.25	1.02	B
Loam	0.19	.52	B
Silt Loam	0.17	.27	C
Sandy Clay Loam	0.14	.17	C
Clay Loam	0.14	.09	D
Silty Clay Loam	0.11	.06	D
Sandy Clay	0.09	.05	D
Silty Clay	0.09	.04	D
Clay	0.08	.02	D

* Source: Rawls, Brakensiek and Saxton, 1982

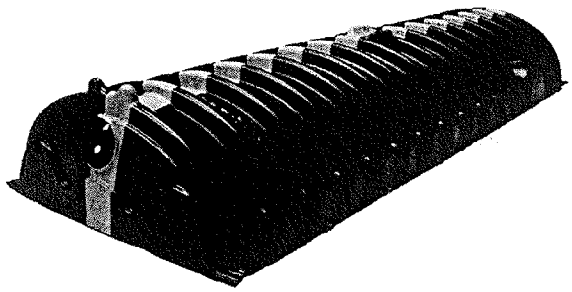
NEWPORT

0" - 24" RANGE = 0.6 - 6.0

BASED ON TEST PIT "A" CONDUCTED ON-SITE WE AGREE WITH LOWER PERMEABILITY VALUE IN (0.6) RANGE FROM MIDDLESEX COUNTY SOIL SURVEY REPORT, WHICH MATCHES LOAM VALUE (0.52 IN/HR) IN RAWLS, BRAKENSIEK AND SAXTON, 1987.

CULTEC Contactor® 100HD

The Contactor® 100HD is a 12.5" (318 mm) tall, low profile chamber and is typically used for installations with depth restrictions or when a larger infiltrative area is required. The Contactor 100HD has the side portal internal manifold feature. The HVLV™ SFCx2 Feed Connector is inserted into the side portal of the Contactor 100HD to create the internal manifold.



Size (L x W x H)	8' x 36" x 12.5"
	2.44 m x 914 mm x 318 mm
Installed Length	7.5'
	2.29 m
Length Adjustment per Run	0.5'
	0.15 m
Chamber Storage	1.87 ft^3/ft
	0.17 m^3/m
	14.00 ft^3/unit
	0.40 m^3/unit
Min. Installed Storage	3.84 ft^3/ft
	0.36 m^3/m
	28.81 ft^3/unit
	0.82 m^3/unit
Min. Area Required	25 ft^2
	2.32 m^2
Min. Center to Center Spacing	3.33'
	1.02 m
Max. Allowable Cover	14'
	4.27 m
Max. Inlet Opening in Endwall	10"
	250 mm
Side Portal Dimensions (H x W)	7" x 7.5"
	178 mm x 191 mm
Max. Allowable Pipe Size in Side Portal	6"
	150 mm
Compatible Feed Connector	HVLV™ SFCx2 Feed Connector

	Stone Foundation Depth		
	6"	12"	18"
	152 mm	305 mm	457 mm
Chamber and Stone Storage Per Chamber	28.81 ft^3	33.81 ft^3	38.81 ft^3
	0.82 m^3	0.96 m^3	1.10 m^3
Min. Effective Depth	2.04'	2.54'	3.04'
	0.62 m	0.77 m	0.93 m
Stone Required Per Chamber	1.37 yd^3	1.84 yd^3	2.30 yd^3
	1.05 m^3	1.40 m^3	1.76 m^3

Calculations are based on installed chamber length.
Includes 6" (152 mm) stone above crown of chamber and typical stone surround.
Stone void calculated at 40%.

Contactor® 100HD Bare Chamber Storage Volumes

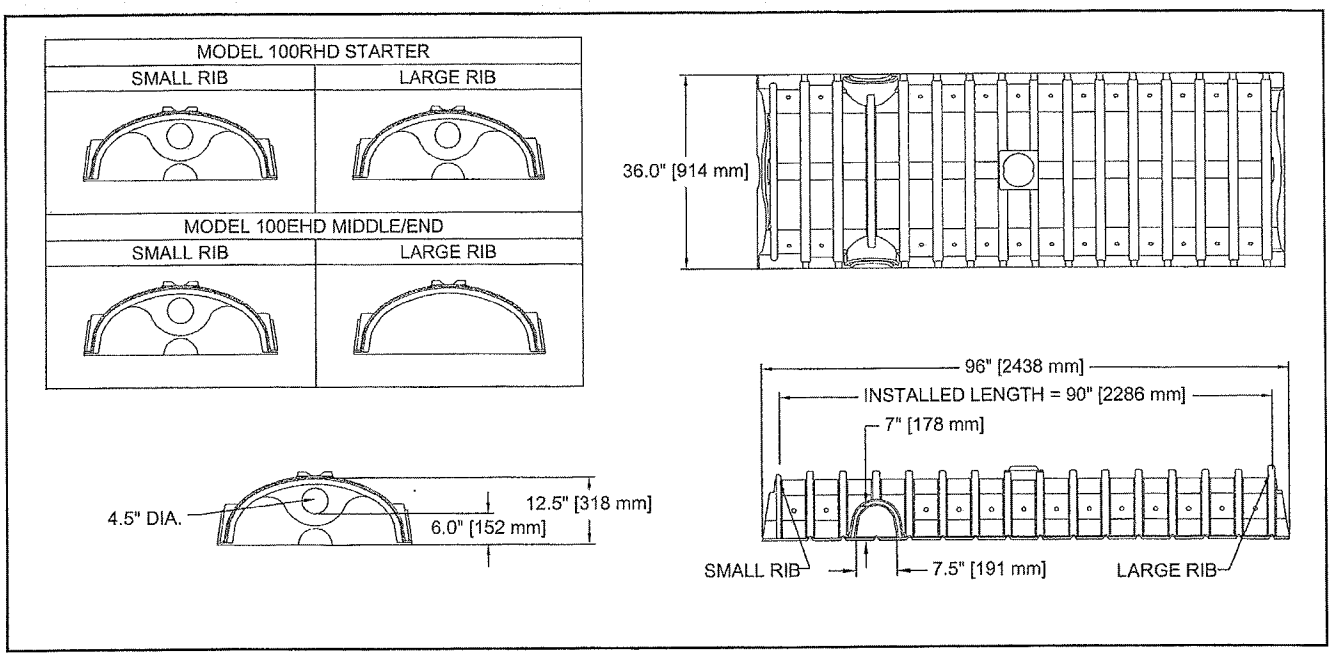
Elevation		Incremental Storage Volume				Cumulative Storage	
in.	mm	ft^3/ft	m^3/m	ft^3	m^3	ft^3	m^3
12	305	0.009	0.001	0.068	0.002	13.995	0.396
11	279	0.067	0.006	0.503	0.014	13.928	0.394
10	254	0.110	0.010	0.825	0.023	13.425	0.380
9	229	0.139	0.013	1.043	0.030	12.600	0.357
8	203	0.159	0.015	1.193	0.034	11.558	0.327
7	178	0.174	0.016	1.305	0.037	10.365	0.294
6	152	0.184	0.017	1.380	0.039	9.060	0.257
5	127	0.192	0.018	1.440	0.041	7.680	0.217
4	102	0.203	0.019	1.523	0.043	6.240	0.177
3	76	0.203	0.019	1.523	0.043	4.718	0.134
2	51	0.203	0.019	1.523	0.043	3.195	0.090
1	25	0.223	0.021	1.673	0.047	1.673	0.047
Total		1.866	0.173	13.995	0.396	13.995	0.396

Calculations are based on installed chamber length.

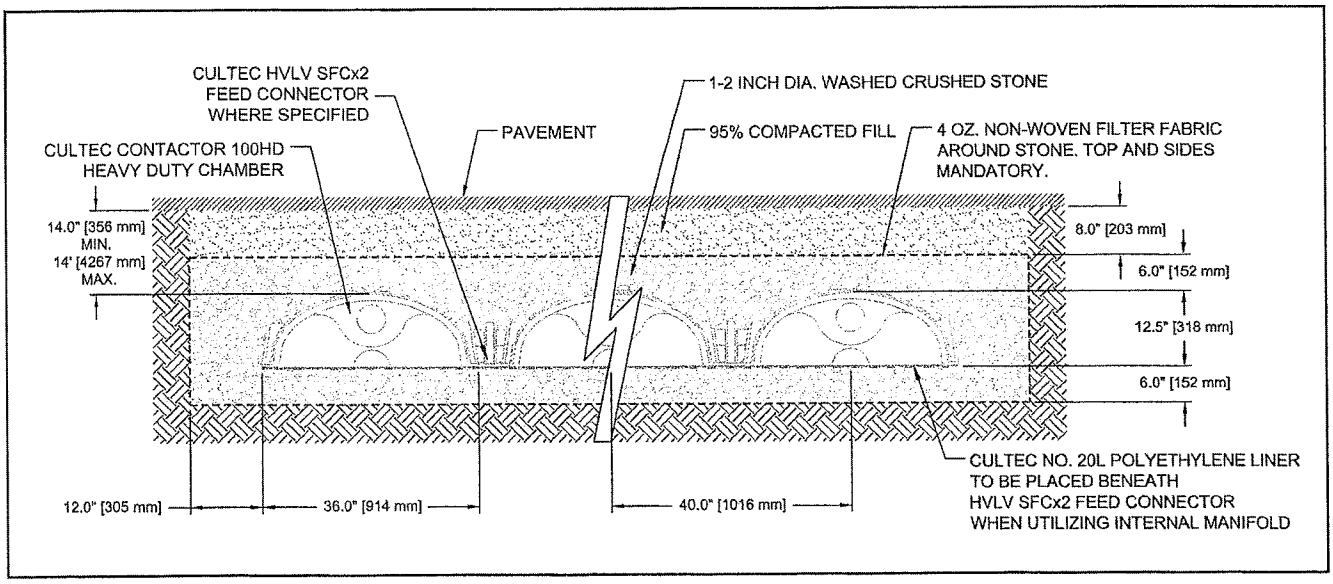
CULTEC

CULTEC Contactor® 100HD

Three View Drawing

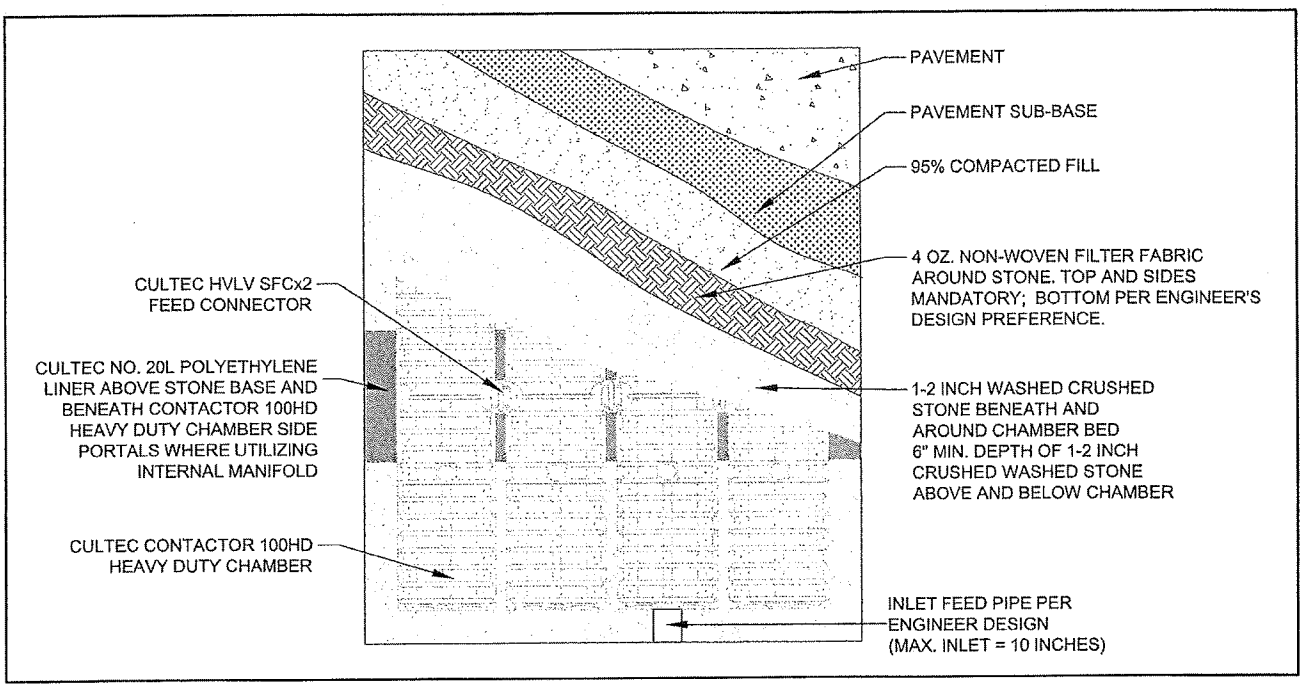


Typical Cross Section for Paved Traffic Application



CULTEC Contactor® 100HD

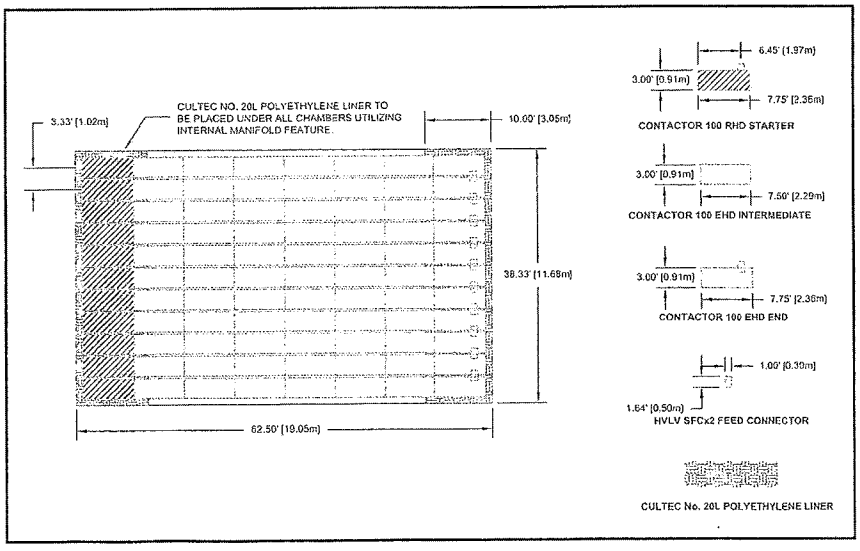
Plan View Drawing



Typical Bed Layout

Using AutoCAD Array Function

1. Add Alternate Units to your Dimension Style and use 0.3048 as the Multiplier
2. Using the Rectangle command, create the three chamber outlines and the feed connectors:
   - Starter: 3.00' x 7.75'
   - Intermediate: 3.00' x 7.5'
   - End: 3.00' x 7.75'
   - Feed Connector: 1.00' x 1.64'
3. Hatch the Starter and End chambers to differentiate them. Place a feed connector (as shown) at one end of the starter and end chambers.
4. Select the Intermediate chamber and select the array command.
5. Specify the number of rows and columns (ex. 10 rows, 7 columns). Do not include the starter and end chambers in the column count.
6. The chambers should be oriented horizontally (as shown). Set the row offset to 3.33' and the column offset to 7.75'. The rotation angle should be 0.
7. Click accept to create the bed.
8. Using the Rectangle command to surround the bed. Offset the rectangle 1' to represent the stone border.
9. Using the Rectangle command create a polyethylene liner underneath the feed connectors at both ends of the bed. It should be 10' wide and span the width of the bed. Apply correct hatching and label the liner.



CULTEC Contactor® 100HD Specifications

GENERAL

CULTEC Contactor® 100HD chambers are designed for underground stormwater management. The chambers may be used for retention, recharging, detention or controlling the flow of on-site stormwater runoff.

CHAMBER PARAMETERS

1. The chambers will be manufactured by CULTEC, Inc. of Brookfield, CT. (203-775-4416 or 1-800-428-5832)
2. The chamber will be vacuum thermoformed of black high molecular weight high density polyethylene (HMWHDPE).
3. The chamber will be arched in shape.
4. The chamber will be open-bottomed.
5. The chamber will be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
6. The nominal chamber dimensions of the CULTEC Contactor® 100HD shall be 12.5 inches (318 mm) tall, 36 inches (914 mm) wide and 8 feet (2.44 m) long. The installed length of a joined Contactor® 100HD shall be 7.5 feet (2.29 m).
7. Maximum inlet opening on the chamber endwall is 10 inches (250 mm).
8. The chamber will have two side portals to accept CULTEC HVLV™ SFCx2 Feed Connectors to create an internal manifold. The nominal dimensions of each side portal will be 7 inches (178 mm) high by 7.5 inches (191 mm) wide. Maximum allowable pipe size in the side portal is 6 inches (150 mm).
9. The nominal chamber dimensions of the CULTEC HVLV™ SFCx2 Feed Connector shall be 7.6 inches (194 mm) tall, 12 inches (305 mm) wide and 19.7 inches (500 mm) long.
10. The nominal storage volume of the Contactor® 100HD chamber will be 1.866 ft^3 / ft (0.173 m^3 / m) - without stone. The nominal storage volume of a joined Contactor® 100HD shall be 13.995 ft^3 / unit (0.396 m^3 / unit) - without stone.
11. The nominal storage volume of the HVLV™ SFCx2 Feed Connector will be 0.294 ft^3 / ft (0.027 m^3 / m) - without stone.
12. The Contactor® 100HD chamber will have fifty-six discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
13. The Contactor® 100HD chamber shall have 16 corrugations.
14. The endwall of the chamber, when present, will be an integral part of the continuously formed unit. Separate end plates cannot be used with this unit.
15. The Contactor® 100RHD Starter unit must be formed as a whole chamber having two fully formed integral endwalls and having no separate end plates or separate end walls.
16. The Contactor® 100EHD Middle/End unit must be formed as a whole chamber having one fully formed integral endwall and one fully open end wall and having no separate end plates or end walls.
17. The HVLV™ SFCx2 Feed Connector must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit will fit into the side portals of the Contactor® 100HD and act as cross feed connections.
18. Chambers must have horizontal stiffening flex reduction steps between the ribs.
19. The chamber will be designed to withstand AASHTO H-25 load rating when installed according to CULTEC's recommended installation instructions.
20. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.
21. The chamber will have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean-out.
22. The units may be trimmed to custom lengths by cutting back to any corrugation on the large rib end.
23. The chamber shall be manufactured in an ISO 9001:2000 certified facility.

MIDDLESEX COUNTY
MASSACHUSETTS

INTERIM

SOIL SURVEY REPORT

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

Published by the

MIDDLESEX CONSERVATION DISTRICT

July, 1995

FOURTH EDITION

NEWPORT series consists of gently sloping to very steep, deep (5+ ft.), dark colored, well drained soils on drumlins in the Boston Basin. They formed in compact glacial till. Newport soils have friable silt loam surface soil and subsoil with moderate permeability over a firm or very firm fine sandy loam to loam substratum (hardpan) at a depth of 15 to 30 inches which has slow or very slow permeability. Newport soils have a very stony surface except where stones have been removed, and have stones below the surface. Major limitations are related to slow permeability in the substratum, slope and stoniness.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

4) Locate the parcel of the soil map. You will note that in mapping, the soils of the parcel are divided into different areas; each area having a different map symbol. This symbol is inside the soil boundary if there is enough room; otherwise, it is outside the area and a leader shows where the symbol belongs. The numerical portion of the map symbol identifies the name of the soil. The letter portion of the symbol identifies the slope of the land:

SYMBOL	PERCENT SLOPE
A	0 - 3 %
B	3 - 8 %
C	8 - 15 % = Slope @ Site
D	15 - 25 %
E	25 - 35 %
DE	15 - 35 %

TABLE B.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organ matt
	In	Pct	G/cc	In/hr	In/In	pH					Pct
265*:											
Charlton	0-5	3-8	1.00-1.25	0.6-6.0	0.08-0.23	4.5-6.0	Low	0.24	3	---	2-5
	5-22	3-8	1.40-1.65	0.6-6.0	0.07-0.20	4.5-6.0	Low	0.24			
	22-65	1-8	1.45-1.70	0.6-6.0	0.05-0.16	4.5-6.0	Low	0.24			
Urban land.											
Hollis	0-14	3-10	1.10-1.40	0.6-6.0	0.12-0.20	4.5-6.0	Low	0.24	1	---	2-5
	14	---	---	---	---	---		---			
266*:											
Newport	0-8	4-10	1.10-1.30	0.6-6.0	0.14-0.24	4.5-6.0	Low	0.28	3	---	2-6
	8-24	3-10	1.30-1.60	0.6-6.0	0.11-0.21	4.5-6.0	Low	0.37			
	24-65	3-10	1.70-2.00	<0.2	0.05-0.12	4.5-6.0	Low	0.24			
Urban land.											
267*:											
Paxton	0-7	3-12	1.00-1.25	0.6-2.0	0.10-0.20	4.5-6.0	Low	0.24	3	---	2-5
	7-22	3-12	1.35-1.60	0.6-2.0	0.08-0.18	4.5-6.0	Low	0.32			
	22-65	3-12	1.70-2.00	<0.2	0.05-0.10	4.5-6.0	Low	0.24			
Urban land.											
268*:											
Haven	0-2	5-18	1.10-1.40	0.6-2.0	0.15-0.25	4.5-6.0	Low	0.32	3	---	2-4
	2-32	2-18	1.25-1.55	0.6-2.0	0.08-0.12	4.5-6.0	Low	0.24			
	32-65	0-3	1.45-1.65	>20	0.01-0.03	4.5-6.0	Low	0.17			
Urban land.											
281A, 281B	0-2	2-12	1.00-1.30	0.6-2.0	0.15-0.20	4.5-6.0	Low	0.28	3	---	2-4
Pittstown	2-17	2-12	1.30-1.60	0.6-2.0	0.15-0.20	4.5-6.0	Low	0.37			
	17-65	2-12	1.70-2.00	0.06-0.6	0.10-0.15	4.5-6.0	Low	0.28			
411	0-10	2-18	1.10-1.50	0.6-6.0	0.14-0.22	4.5-7.3	Low	0.32	5	---	2-4
Occum	10-17	2-12	1.20-1.50	0.6-6.0	0.10-0.20	4.5-6.5	Low	0.20			
	17-28	2-8	1.20-1.50	0.6-2.0	0.10-0.18	4.5-6.5	Low	0.20			
	28-65	0-5	1.30-1.60	>6.0	0.01-0.10	4.5-6.5	Low	0.17			
555*	0-6	---	---	---	---	---		---	---	---	---
Udorthents	6-60	---	---	---	---	---		---			
591A, 591B	0-8	2-15	1.20-1.50	0.6-2.0	0.18-0.21	4.5-6.0	Low	0.49	3	---	2-4
Scio	8-35	2-15	1.20-1.50	0.6-2.0	0.17-0.20	4.5-6.0	Low	0.17			
	35-65	0-5	1.45-1.65	2.0-20.0	0.02-0.19	5.1-7.8		0.17			
601	0-8	3-16	1.20-1.50	0.2-2.0	0.18-0.24	5.1-7.3	Low	0.49	3	---	3-6
Raynham	8-33	3-16	1.20-1.50	0.2-2.0	0.18-0.22	5.1-7.3	Low	0.64			
	33-65	3-16	1.20-1.60	0.06-0.2	0.17-0.21	5.6-7.8	Low	0.64			
602	0-8	3-12	1.00-1.25	0.6-2.0	0.16-0.28	4.5-5.5	Low	0.49	3	---	2-4
Raypol	8-29	3-12	1.35-1.55	0.6-2.0	0.15-0.26	4.5-5.5	Low	0.49			
	29-52	0-2	1.40-1.65	>6.0	0.01-0.10	4.5-5.5	Low	0.10			
	52-65	0-2	1.40-1.65	>6.0	0.01-0.10	4.5-6.5	Low	0.10			
611	0-15	3-16	1.00-1.10	0.2-2.0	0.17-0.30	4.5-6.0	Low	0.49	5	---	2-4
Birdsall	15-30	3-16	1.20-1.50	0.2-0.6	0.15-0.26	5.1-7.3	Low	0.64			
	30-65	3-16	1.20-1.50	0.06-0.2	0.15-0.26	5.1-7.3	Low	0.64			

0.52 USED WHICH IS LOWER VALUE FOR THIS TABLE

See footnote at end of table.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wastewater Permitting Program

163 HUDSON STREET
Site Address or Map/Lot Number

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Conducted By: STAMSKI AND McNARY, INC. AUSTIN, MA

C. On-Site Review *(minimum of two holes required at every proposed disposal area)*

Deep Observation Hole A: 11-4-2010 (Date) _____ (Time) RAIN 50° (Weather)

1. Deep Observation Hole Logs

   Deep Hole Number _____ Ground Elevation at Surface of Hole 19.35'

   Location (Identify on Plan) 163 HUDSON STREET SOMERVILLE, MA

2. Land Use: EXISTING RESIDENTIAL LOT (e.g. woodland, agricultural field, vacant lot, etc.) _____ (Surface Stones) 8-15% (Slope %)

   GRASS (Vegetation) _____ (Landform) _____ (Position on landscape (attach sheet))

3. Distances from: Open Water Body — feet Drainage Way — feet Possible Wet Area — feet

   Property Line 15'± feet Drinking Water Well CITY feet Other WATER (MWRA)

4. Parent Material: COMPACT - GLACIAL TILL Unsuitable Materials Present: Yes ☒ No ☐

   If Yes: Disturbed Soil ☐ Fill Material ☒ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock ☐

   GENERAL FILL MATERIAL WITH 36" OF SURFACE. REMNANT AMERICAN FOOTING ALSO ENCOUNTERED

5. Groundwater Observed: Yes ☐ No ☒

   If Yes: Depth Weeping from Pit: DRY Depth Standing Water in Hole DRY

   Estimated Depth to High Groundwater: 48" * (Inches) 15.35' * (elevation)

   * POSSIBLE RELIC MOTTLING PRIOR TO DENSE DEVELOPMENT AND IMPLEMENTATION OF DRAINAGE SYSTEM

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wastewater Permitting Program
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

163 HUDSON STREET
Site Address or Map/Lot Number SOMERVILLE, MA

Deep Observation Hole A: Deep Hole Number: TP - A

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-36"	A + FILL		—	—	—	SANDY LOAM		10%	GENERAL FILL	FRIABLE	REMNANT FOOTING & FENCE POST
36"-112"	C		* 48"	5YR 5/8	>5%	SANDY LOAM	—	2	MASSIVE	FRIABLE TO FIRM	
			*	POSSIBLE							
				RELIC MOTTLING							

Additional Notes REAR OF LOT ALONG FENCE APPEARS TO BE FILLED APPROXIMATELY TWO FEET TO EDGE OF FENCE, RECOMMEND REMOVAL OF FILL BENEATH & WITHIN 5 FEET OF ANY PROPOSED DWELLING.

OBSERVATION PIPE INSTALLED

OPERATION & MAINTENANCE PLAN

Operation & Maintenance Plan

Roof Drywell

- Inspection – After every major storm event in the first few months after construction to ensure proper stabilization and function. Thereafter, inspect annually.

- Cleaning – Annually inspect flat roof area for leaf litter and debris. Remove all leaf litter to prevent clogging.

Permeable Pavers

Frequent cleaning and maintenance of the permeable paver surface is critical to prevent clogging. Operation and Maintenance of the permeable paver area shall be conducted in accordance with the most recent recommendations of the Interlocking Concrete Pavement Institute (www.icpi.org) and as provided with the Design Plan and Operation Manual to be provided by selected paver company prior to installation.

At a minimum, the following monitoring, sweeping, washing and maintenance shall be conducted in accordance with the recommendations provided within the MA Stormwater Handbook Part 2; dated February 2008 for Porous Pavement.

- Sweeping - Annually.

- Jet Washing Surface - Every 24 months.

- Joint Material - Periodically add joint material (sand) to replace material that has been transported (per ICPI Tech Spec Number 5).

- Minimize salt use during winter months.

- No winter sanding is allowed.

- Keep adjacent landscaped areas well maintained to prevent soil from being transported onto the permeable paver area.

- Monitoring – After every major storm event in the first few months after construction to ensure proper stabilization and function. Thereafter, inspect annually to make sure it drains properly after storms.

- Never reseal or repave with impermeable materials.

- Inspect the surface annually for deterioration or spalling. Replace individual pavers as necessary from excess stockpile of pavers to be stored within cellar to be available for replacement if necessary.

ICPI INTERLOCKING CONCRETE PAVEMENT INSTITUTE®

TECH SPEC

NUMBER • 5

Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement

When properly installed, interlocking concrete pavements have very low maintenance and provide an attractive surface for decades. Under foot and vehicular traffic, they can become exposed to dirt, stains and wear. This is common to all pavements. This technical bulletin addresses various steps to ensure the durability of interlocking concrete pavements and to help restore their original appearance. These steps include removing stains and cleaning, plus joint stabilization or sealing if required.

Stains on specific areas should be removed first. A cleaner should be used next to remove any efflorescence and dirt from the entire pavement. A newly cleaned pavement can be an opportune time to apply joint sand stabilizers or seal it. In order to achieve maximum results, use stain removers, cleaners, joint sand stabilizers, and sealers specifically for concrete pavers. These may be purchased from a manufacturer, contractor, dealer or associate member of the Interlocking Concrete Pavement Institute.

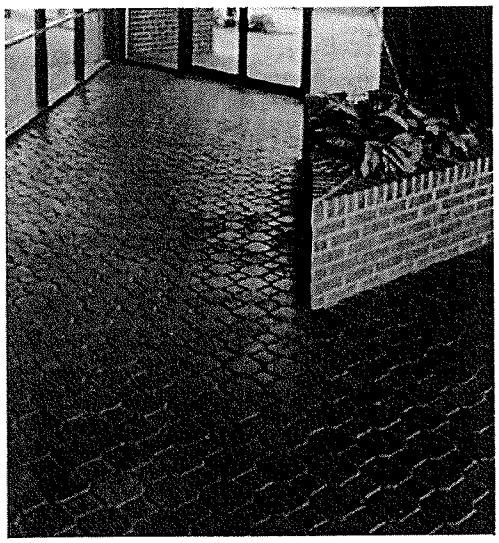


Figure 1. Many sealers enhance the appearance of concrete pavers and protect against staining.

REMOVING STAINS

Commercial stain removers available specifically for concrete pavers provide a high degree of certainty in removing stains. Many kinds of stains can be removed while minimizing the risk of discoloring or damaging the pavers. The container label often provides a list of stains that can be removed. If there are questions, the supplier should be contacted for help with determining the effectiveness of the chemical in removing specific stains.

Identify the stains prior to applying the cleaner. A test application should be evaluated in a small, inconspicuous stained area for cleaning effectiveness. Some stains may require repeated applications of the remover to achieve effective cleaning. This is often the case for deep set oil stains. With all stain removers, cleaners, joint sand stabilizers, and sealers, the label directions and warnings should be read and carefully followed for all precautions.

Start removal of stains at the bottom of the pavement and work up the slope in manageable sections. By working up the slope, cleaning fluids will drain down the pavement. This technique assists in uniform removal while allowing the used cleaner to be rinsed away consistently. The surface remains dry ahead of the cleaner-soaked wet areas, allowing better visibility of the stains to be removed.

Take care in selecting and applying cleaning products, as acidic ones may harm vegetation and grass. These cleaners should not run onto vegetation. When using strong acidic stain removers or cleaners that might drain onto vegetation, saturate the vegetation with water prior to using acidic cleaners. This will minimize absorption of cleaner rinse water and reduce risk of damage to vegetation.

Removal of Common Stains

There are proprietary cleaning products specifically designed for concrete pavers. Many have been developed through extensive laboratory and field testing to ensure cleaning effectiveness. These chemicals should be used whenever possible. Using manufactured cleaning chemicals for specific stains relieves the user from the uncertainty of attaining the proper mixture of chemicals.

If no proprietary stain removal products are available, a comprehensive source of information on stain removal is found in *Removing Stains from Concrete* by William H. Kuenning. It describes chemicals, detergents or poultice (scrubbing) materials recommended for removing particular stains, and the steps to be followed in removal. This publication recognizes

that some of the treatments involve hazardous chemicals and it advises specific precautions.

Removal of several common stains from *Removing Stains from Concrete* are listed below (1). Most involve typical household chemicals. The information given is the best available at the time of writing. The ICPI disclaims any and all responsibility for the application of the information. The user is advised to use cleaners specifically made to remove stains that commonly occur on concrete pavers. They will likely be more effective.

Asphalt and emulsified asphalt—Chill with ice (if warm outside), scrape away and scrub the surface with scouring or abrasive powder. Rinse thoroughly with water.

Cutback asphalt and roofing tar—Use a poultice made with talc or diatomaceous earth. Mix with kerosene, scrub, let dry and brush off. Repeat as needed.

Blood, candy, ketchup, mustard, grease drippings from food—For stubborn stains, apply liquid detergent full strength and allow it to penetrate for 20 to 30 minutes. Scrub and rinse with hot water. Removal is easier if these stains are treated immediately.

Caulking—Scrape off excess and scrub with a poultice of denatured alcohol. Rinse with hot water and detergent. Acrylic latex caulk—follow guidelines for removal of latex paint.

Chewing gum—Same as caulking, or scrub with naphtha.

Clay soil—Scrape off dry material, scrub and rinse with hot water and strong detergent.

Creosote—Apply a poultice with paint thinner and talc. Scrub and allow to dry. Scrape off, scrub with scouring powder and rinse with water.

Leaf, wood rot, or tobacco stains—apply household bleach and scrub with a stiff bristled brush.

Mortar—Let harden and carefully remove hardened spots with a trowel, putty knife or chisel.

Smoke—Scrub with a poultice of talc with bleach diluted 1:5 with water. Rinse with water.

Oil or grease that has penetrated—Mop up any excess oil with rags. Cover the area with oil absorbent (kitty litter). Talc, fuller's earth, diatomaceous earth can be used. Leave it on the stain for a day then sweep up.

Paint—Fresh paint should be mopped up immediately with rags or paper towels by blotting. Do not wipe as this will spread the paint and extend the job of removal. If the paint is latex and water based, soak and then scrub the area with hot water, scouring powder and a stiff brush until no more improvement is seen. Let the remaining paint dry and remove as described below.

Dried paint—Scrape any excess oil based paint, varnish or water based latex paint off the surface. Apply a commercial paint remover and let it sit for 20 to 30 minutes. Loosen with gentle scrubbing. Do not rub the loosened paint into the surface of the paver. Instead, blot up the loosened paint and thinner. Repeat as necessary.

Tire skid marks—Scrub black area with water, detergent and scouring powder.

In the case of small stained areas, removal and replacement with new pavers may be an option.

OVERALL CLEANING

Overall cleaning of the pavement can start after stains are removed. In preparation for cleaning, low tree branches, shrubs and vegetation adjacent to the pavement should be tied back or covered to protect from overspray of cleaning solutions or sealers. The area should be inspected for any cracked or broken units. These should be replaced. Badly stained units can be replaced, but it is usually easier to clean stains and less costly than replacing the pavers.

When pavers have stains too difficult to remove, replace them with the same type of units. Refer to ICPI *Tech Spec 6, Reinstatement of Interlocking Concrete Pavements*, for a full description on replacing pavers. If pavers must be replaced, there may be a difference in color from the surrounding pavers. This variation should eventually disappear. If color variation is unacceptable, controlled use of proprietary cleaners designed to improve the color of concrete pavers can minimize variation.

Removal of accumulated dirt and efflorescence is the objective of cleaning. It is essential in preparing the pavers for sealing as well. Many cleaners effective in removing dirt and efflorescence are a mix of detergent and acid. Cleaners with strong acids will change the color of the pavers slightly. The degree of change can be controlled by the type of acid in the cleaner, its concentration and the length of time on the pavers. Proprietary cleaners will give specific instructions on their application. These directions should be followed. In order to achieve proper results, cleaners should be tried on a small area to test results and any color changes. The concentration and time on the pavement can be adjusted accordingly. Protective clothing and goggles should always be worn when using acidic solutions.

Anticipate where the cleaning fluids will drain, i.e, across the pavement and not onto grass or vegetation. Sediment or cleaners allowed to pond in low spots may stain the pavers. If unsure of the runoff direction, test drainage with ordinary water first to identify any trouble spots. Be sure to rinse these areas thoroughly. Turn off all automatic sprinkler systems during cleaning, sealing and drying.

Professional Cleaning Methods

For most jobs, cleaning should be handled by a professional company experienced in the use of cleaners and spray equipment. Professionals typically use a pressure washer and an applicator to apply efflorescence cleaner (when needed). The various methods for applying joint sand stabilizers and sealers are covered later.

A high pressure sprayer applies cleaner and water between 600 and 2,000 psi (4.1 and 13.8 MPa), and at a rate between 6 and 12 gallons/minute (22 and 45 liters/minute). See Figure 2. The rate of flow is adjusted to ensure sufficient rinsing. The pressure loosens dirt and pushes water from the surface without the need for scrub brushes. The nozzle type and its distance from the paver surface influences the effectiveness of the cleaning as well. A nozzle that creates a wide spray enables a large area to be covered efficiently and prevents sand from being washed from the joints. A low angle of attack from a wide nozzle spray will also reduce the risk of dislodging joint sand.

Cleaners to remove efflorescence are applied with a low pressure pump spray 30 to 100 psi (0.2 to 0.7 MPa). A shower type spray nozzle will help ensure even distribution of the cleaner. Cleaning chemicals are applied, allowed to sit an appropriate time, then rinsed away with a high pressure sprayer. The final rinse should be water only. A large amount of water is more important to rinsing than high pressure.

For small areas, an adequate cleaning job can be achieved without this equipment. Such areas include residential patios, walks, or small driveways. Cleaners can be applied by hand, the pavers scrubbed to remove dirt and efflorescence, then thoroughly rinsed

with water from a garden hose. Scrub brushes with steel bristles are not recommended. They will loosen from the brush, rust, and leave stains. Brass or plastic bristles are acceptable. This method of cleaning is for do-it-yourselfers who wish to refurbish a small area of pavers.

The additional time required to clean and seal pavers without the help of a professional should be weighed against investing in a competent company to do the job. Professionals have the equipment and experience with the various chemicals. They can achieve the highest level of results in the least amount of time.

Efflorescence and Its Removal

Efflorescence is a whitish powder-like deposit which can appear on concrete products. When cement hydrates (hardens after adding water), a significant amount of calcium hydroxide is formed. The calcium hydroxide is soluble in water and migrates by capillary action to the surface of the concrete. A reaction occurs between the calcium hydroxide and carbon dioxide (from the air) to form calcium carbonate, then called efflorescence.

Efflorescence does not affect the structural performance or durability of concrete pavers. The reaction that takes place is the formation of water soluble calcium bicarbonate from calcium carbonate, carbon dioxide and water. It may appear immediately or within months following installation. Efflorescence may reach its peak in as short as 60 days after installation. It may remain for months and some of it may wear away. If installation takes place during dry period of the year, the next cycle of wet weather may sometimes be necessary for efflorescence to materialize.

If there is a need to remove deposits before they wear away, best results can be obtained by using a proprietary efflorescence remover. The acid in proprietary cleaning chemicals is buffered and blended with other chemicals to provide effective cleaning without damage to the paver surface. Always refer to the paver supplier or chemical company supplying the chemicals for recommendations on proper dilution and application of chemicals for removal of efflorescence. They are generally applied in sections beginning at the top of slope of the pavement. If the area is large, a sprayer is an efficient means to apply the cleaner. The chemicals are scrubbed on the surface, then rinsed away. Results can be verified after letting the area dry for at least 24 hours. In most instances one application is sufficient. However, in severe instances of efflorescence, a second application may be necessary. Contact the manufacturer of the cleaning product to determine if a second application will not discolor the pavers or expose some aggregates. Note: Protective clothing, chemical resistant rubber boots and gloves, and eye goggles should be worn when applying acid or alkalies.

Figure 2. Pressurized cleaning equipment used by professional cleaning and sealing companies can bring out the best appearance from pavers.

JOINT SAND STABILIZERS AND SEALERS

Stabilizer and sealers are two distinct products sometimes with overlapping functions. Joint sand stabilizers help secure sand in the joint after it has been installed. Their primary function reduces the risk of removal of joint sand from flowing water, wind, aggressive cleaning, tire action and intrusion of organic matter, seeds and ants.

Joint sand stabilizers come in liquid and dry applied forms. Some liquid stabilizers are made of the same materials as sealers, but with a higher solids content with additional wetting agents. When applied to the paver surface and joints, stabilizers can make the surface easier to clean and prevent staining in a manner similar to sealers. Depending on the chemical contents, liquid stabilizers may or may not change the appearance of the paver surface.

All surface sealers are applied as liquids. Their primary function is providing additional protection to concrete paver surfaces. Such chemicals can be similar to products used to seal cast-in-place concrete slabs. Sealers are applied to the entire surface of an installation to add further protection from stains, oils, dirt, or water. Occasionally, sealers are applied to pavers during manufacturing. Whether applied in a factory or on a site, most sealers change the appearance of the paver surface by darkening it and enhancing the surface color. Since liquid sealers penetrate the joint sand to some extent during application, they secondarily provide some stabilization.

Joint Sand Stabilizers

Liquid and dry applied stabilizers provide initial protection against joint sand loss. They accelerate joint sealing that can normally occur from a combination of atmospheric dust deposits, dirt and sediment that finds its way to the pavement, and contributions from passing tires. Stain removal, efflorescence removal, and overall surface cleaning should precede application of liquid stabilizers in new construction. None of these preparatory treatments are needed prior to the application of a dry applied stabilizer. It is applied first with the joint sand to complete the paver surface and begin interlock. Stain and efflorescence removal, cleaning and sealing can be done subsequently.

Joint sand stabilization materials are fairly new, so no industry-wide guidelines yet exist on the expected lifetime or reapplication rates. Some stabilized joints in pavements show years of longevity. There is evidence that projects in freeze-thaw climates have performed well for more than six years.

Joint sand stabilization is generally optional and not required for many interlocking concrete pavements. Sand in joints will likely stabilize over time without additional treatment as a result of silts or other fines working their way into spaces between the sand particles. The rate of stabilization depends on the amount and sources of traffic, plus sources of fines that work their way into the joints from traffic over time.

Figure 3. This liquid joint sand stabilizer is applied with a low-pressure sprayer and squeegeed across the surface after allowing some time for soaking into the joints. This helps maintain slip and skid resistance of the paver surface.

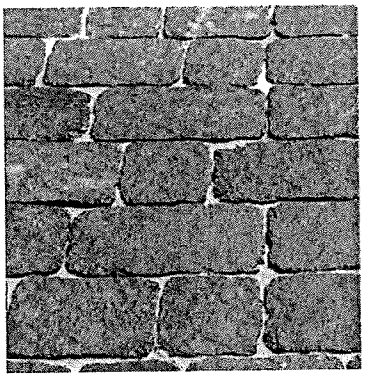


Figure 4. Liquid joint sand stabilizers can deepen the surface color slightly and they provide some surface sealing as well. Tumbled pavers shown here have wider joints than other shapes. These type of pavers can require stabilization of the joint sand.

Figure 5. Joint sand can be pre-mixed and delivered to the site (typically in bags), or mixed with stabilizer at the site, then swept into the joints, compacted for consolidation in them to create interlock, and wetted to activate the stabilizer.

There are some applications where early stabilization of the joints is important to maintaining functional performance of the paver surface. For example, stabilization is recommended on high slope applications over 7% and on applications where the slope is less than 1.5%. Applications on high slopes will help prevent washout of joint sand. Stabilizers in very low slope or flat areas can help reduce infiltration of standing water.

Stabilization benefits pavements subject to aggressive, regular cleaning. Examples might include amusement parks and restaurant exteriors. Pavements that see regular, heavy rainfall can benefit from stabilization of the joint sand. Surfaces that experience concentrated water flow such as gutters receiving sheet flow from large areas or at the drip lines under the eaves of buildings will better resist erosion of joint sand if stabilized.

Stabilizers have been effective in securing joint sand in places subject to high winds such as in desert climates. They can prevent joint sand displacement from high-speed tire traffic. Like sealers, joint and stabilization materials reduce the potential for weeds and ants in the joints. In residential applications stabilization at downspouts and under eaves helps keep joint sand in place. Tumbled pavers (cobble stone-like units) and circular patterns have wider joints than other paver shapes. Tumbled pavers may require stabilized joint sand between them if they have slightly irregular sides and wide joints.

Studies on the permeability of the surface of interlocking concrete pavements have indicated ranges between 10% and 20% perviousness (2). The rate of permeability depends on several factors. They include the fineness of the joint sand (percent of material passing the No. 200 or 0.075 mm sieve), the joint widths, slope, consolidation of the sand plus the age of the installation. Newly placed pavers have higher permeability (as much as 25%) than installations trafficked for several years. Sealers and joint sand stabilizers can contribute to long-term performance by reducing infiltration of water to the bedding sand and base.

Liquid Penetrating Stabilizers

These are water or solvent-based with the primary resin or bonding agent being an acrylic, epoxy, modified acrylic, or other polymers as solids (by volume) typically 18% to 28%. Solvent or water carries the solids into the joint sand. They will evaporate and leave the solids behind as the binding agent. Modifiers such as epoxy resins may also add to the ability of the product to create a solid matrix in the joint sand. When initially applied, liquid stabilization materials should be allowed to penetrate at least 3/4 inch (20 mm) into the joint sand. A mock-up is beneficial in determining application rates for specific products, joint sands, and for specific job site conditions.

Joint sand gradation can affect the depth of penetration of the liquid stabilizer. The amount of fines or material passing the No. 200 (0.075 mm sieve) can influence the depth of penetration. A joint sand gradation with less than 5% passing the No. 200 (0.075 mm) sieve can allow better penetration of liquid stabilizers. A job site mock-up

Figure 6. Whether using liquid or dry joint stabilization materials, the surface of the pavers should be cleaned with a blower or broom after the joint sand is compacted into the joints.

Figure 7. Dry-applied joint sand with a stabilizer is wetted in order to activate it and stiffen the sand. Once the joints dry, they are stabilized.

should be tried to determine the penetration rate. The mock-up also will determine the appropriate application rate.

Prior to applying liquid materials, the surface should be clean and dry and any efflorescence removed from the pavers. Either a broom or leaf blower can efficiently remove excess sand. Some successful methods of application involve applying liquid joint stabilizers with low pressure, high volume spray, followed immediately by a squeegee to move the material into the joints. See Figure 3. Other methods use rollers, watering cans, or hand pumped, garden-type sprayers. Some equipment has multiple spray nozzles and mechanized rollers and/or squeegees. All application methods must provide uniform dispersion and effective penetration.

Liquid stabilizers bind the sand in the joint and secondarily provide sealing of the concrete paver surface. All liquid based stabilizers create some change in the appearance of the pavers. This ranges from a slight color enhancement, a modest sheen, to a high gloss. Like sealers, cured liquid joint stabilizers that remains on the surface of the pavers enhances their color, inhibits fading, and protects against staining. It also makes the paver surface easier to clean and maintain (Figure 4). However, joint sand stabilization will last significantly longer than the enhancement of the surface appearance.

Dry Joint Sand Stabilizers

These are dry additives mixed with joint sand. The additives are organic, inorganic, or polymer compounds that stiffen and stabilize the joints when activated by water applied to the joint sand. Additives come either pre-mixed with bagged joint sand, or are sold separately as an additive mixed with the joint sand on the job site per the supplier's instructions. The additive is often mechanically mixed for consistency. Dry stabilizers are appropriate for residential settings, parking lots, bike lanes, plazas, and other areas with low velocity wheel loads or areas without concentrated water flow. They are convenient for application by homeowners. Some dry stabilizers have been successfully used in high traffic streets.

The pavers are initially compacted into the bedding sand. Joint sand is applied to the surface with a stabilizer additive mixed in it. See Figure 5. It is then compacted into the joints with a plate compactor like all interlocking concrete pavement installations. After compaction and removal of all sand from the paver surface, the joints are wetted. When dry, the material in the sand stabilizes the full depth of the joint and it helps maintain interlock among the pavers. For either pre-mixed or job site mixed additives, a job site mock-up is beneficial for determining the depth of stabilization. The mock-up will determine the rate and application method of water to ensure full activation of the stabilizer. A mock-up will confirm a consistent method for uniform distribution of the additive in the sand for job site mixed additives in particular.

Prior to application, blowing or sweeping the surface clean is recommended. See Figure 6. Since water activates these products, no moisture should be present on the surface or in the joints until they are ready to be placed in the joints. Once the pavers and joint sand are compacted, the joints are full of sand, and all excess sand is removed from the surface, water is added to activate the bonding agent. The water is applied as a light, wide spray, and allowed to collect and soak into the joints (Figure 7). A narrow spray should not be used because it can dislodge sand from the joints. It is imperative to immediately remove any excess moist joint sand that inadvertently gets on the surface of the pavers. Otherwise, once it is moistened and allowed to cure on the surface, the sand will need to be removed with hot water. Some stabilizers may require removal with a wire brush or a pressure washer. Dry products will not leave a surface sheen like liquid stabilization products. This can be beneficial for a contractor or owner who needs to stabilize isolated areas through selected application of the product.

Installation, Functional and Structural Considerations

Liquid and dry applied joint stabilizers are not a substitute for recommended installation practices. Prior to their application, all liquid stabilization products require that the joint sand be compacted and consolidated in the joints until full. Some dry stabilizers require mixing with joint sand then sweeping, filling, and compacting the sand and pavers until the joints are full. Other stabilizers are premixed in bags and are ready for filling the joints. Stabilizers resist many of

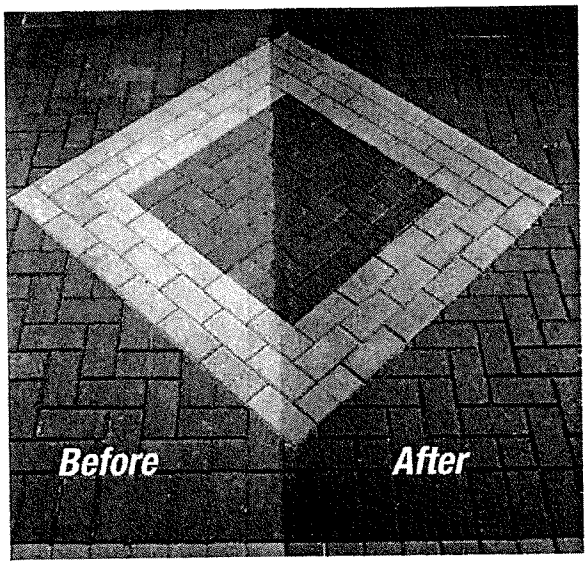


Figure 8. Before and after application of an acrylic sealer shows how it deepens the appearance of concrete pavers.

Photo courtesy of Resiblock

Figure 9. Sealers resist stains which makes them ideal for high use areas where they might occur.

environmental factors that lead to functional deterioration of the paver surface. However, stabilizers do not add to the structural (load bearing) capacity of the pavement. Therefore, structural calculations for base thickness design should not consider a joint sand stabilizer.

SEALERS

Uses

Sealers reduce the intrusion of water, stains, oils and dirt into the paver surfaces. Like stabilizers, application of a sealer follows stain removal, efflorescence removal and overall surface cleaning. Sealers are used for visual and functional reasons. They offer visual improvement by intensifying the paver colors. Some will add a glossy sheen or "wet" look to the pavement (see Figure 8). Other sealers offer some color enhancement and produce a low sheen, or a flat finish.

Sealers offer many functional advantages. They can protect pavers from stain penetration. They are useful around trash receptacles, fast food restaurants, driveways, other areas subject to stains, and where oil drippings are not wanted (see Figure 9).

Like stabilizers, sealers are also useful in stopping unwanted insects and weeds. Sealers can stabilize joint sand between pavers cleaned by vacuum sweeping equipment. They can help maintain the sand in the joints under high velocity water flows. Where solvents may be spilled onto pavers, elastomeric urethanes and certain water based sealers have been successfully used to prevent their penetration. Likewise, special urethane sealers have been used to seal and stabilize joint sand subject to propeller wash, jet engine fuels and exhaust in commercial and military airports (2).

Types of Sealers for Concrete Pavers

Table 1 lists the various types of sealer for concrete pavers. The table suggests applications and compares important properties (3). The sealer manufacturer or supplier should be consulted prior to using any sealer to verify that their product will perform in the environment planned for its use. Sealers not recommended for use with pavers are alkyds, esters, and polyvinyl acetates. Epoxies and silicones are generally not used on concrete pavers.

Solvent and Water Based Sealers

Like stabilizers, sealers can be either solvent or water based. Solvent based sealers consist of solids dissolved in a liquid. Solvent based products carry the dissolved solids as deep as the solvent will penetrate into the concrete paver. After the solvent evaporates, the sealer remains.

Water based sealers are emulsions, or very small particles of the sealer dispersed in water. Water based sealers penetrate concrete as far as the size of the particles will permit. After the water evaporates, typically at a slower rate than solvents, the remaining particles bond with the concrete and to each other. These particles cannot penetrate as deeply as those carried by solvents. Water based sealer curing time will vary with the temperature, wind conditions and humidity.

Silanes/Siloxanes

Silanes and siloxanes are durable and penetrate concrete well. Silanes are the simpler form that, when exposed to moisture, begin to link up to other silanes. Siloxanes do the same linking together. Both chemicals become a polymer, curing as a film in the capillaries of the concrete. A hydrophobic barrier to moisture is created, preventing moisture from entering but allowing the concrete to "breathe" or release water vapor.

Because silanes and siloxanes reduce moisture from entering the concrete, they can deter efflorescence from appearing on the surface of concrete pavers. They initially enhance colors and produce a flat, no-gloss finish on the paver surface. This makes silanes and siloxanes very suitable on exterior areas for resisting efflorescence when a glossy surface is not desired.

Silanes and siloxanes do not resist penetration of petroleum stains unless they have additives specifically for that purpose. When required, proprietary mixtures with additives can increase petroleum stain resistance. Other additives can ensure greater consistency in the color of pavers and avoid a blotchy appearance.

Silanes have smaller molecules, so they penetrate farther into the concrete than larger siloxane molecules. However, they are more volatile (tend to evaporate) until they bond to the concrete paver. Silane sealers generally require a higher percent of solids to counteract their rate of evaporation. Therefore, silanes tend to be more expensive than siloxanes.

Silanes and siloxanes are typically used as water repellents for concrete bridge decks, parking garages, and masonry walls. Their primary use for reinforced concrete structures is to prevent the ingress of chloride ions from de-icing salts(4). This intrusion causes reinforcing steel corrosion in the concrete, and a weakened structure. Their ability to decrease intrusion of chloride materials provides additional protection of pavers subject to deicing salts or salt air, such as walks, streets, parking lots, plaza roof and parking decks. They are also useful around pool decks to minimize degradation from chlorine.

Most silane and siloxane sealers are solvent based. Certain manufacturers offer water based products as well. These products may have a very short shelf life after the silane or siloxane has been diluted with water. The user should check with the manufacturer on the useful life of the product.

Acrylics

Acrylic sealers can be solvent or water based. They enhance paver colors well and create a gloss on the surface. Acrylic sealers provide good stain resistance. Their durability depends on traffic, the quality of the acrylic and the percentage of solids content. They provide longer protection from surface wear than silanes or siloxanes.

Acrylic sealants are widely used in residential and commercial paver applications. They generally last for a few years in these applications before re-coating is required. Acrylics specifically developed for concrete pavers do not yellow over time. When they become soiled or worn, pavers with acrylics can be easily cleaned and resealed without the use of extremely hazardous materials.

Acrylics should not be used on high abrasion areas such as industrial pavements or floors. Water based acrylics perform well for interior applications. They may be allowed by municipalities that regulate the release of volatile organic contents (VOCs) in the atmosphere.

Urethanes

As either solvent or water based, polyurethanes produce a high gloss and enhance the color of pavers. Aromatic urethanes should contain an ultra-violet (UV) inhibitor to reduce yellowing over time. The product label should state that the sealer is UV stable. Urethanes themselves are more resistant to chemicals than acrylics.

While aliphatic urethanes can be used for coating the surface

Table 1—Properties of Sealers for Concrete Pavers—Confirm application and properties with supplier.

	Patios, walks, pool decks	Residential/ Comlercial drives	Gas Stations Airports	Areas subject to chlorine & heavy de-icing salts	Finish	Enhances color	Joint sand stabilizer	UV resistant	Can be re-coated	Ease of removal	Price
Silane	Yes	Yes		Yes	Flat	*		Yes	Yes	Mod.	++
Siloxane	Yes	Yes		Yes	Flat	*		Yes	Yes	Diff.	++
Acrylic	Yes	Yes			Gloss	Yes	Yes	Varies	Yes	Diff.	+
Urethane	Yes	Yes	Yes	Yes	Gloss	Yes	Yes	Varies	No	V. Diff.	++
Water-based Epoxy	Yes	Yes	Yes	Yes	Semi-Gloss	Yes	Yes	Yes	Yes	Mod.	++

*Initially, then diminishes. Diff.=Difficult V. Diff.=Very Difficult +=Moderate Price ++=Higher price

of pavers, elastomeric (aromatic or aliphatic) urethanes should be used where the primary need is to stabilize joint sand. For airfield and gas station applications, the urethane should have a minimum elongation of 100% per ASTM D 2370, Standard Test Method for Tensile Properties of Organic Coatings. Urethanes resist degradation from petroleum based products and de-icing chemicals. This makes them suitable for heavy industrial areas, as well as airfield and gas station pavements.

Urethanes cannot be rejuvenated simply by re-coating. If urethane sealers must be removed, methylene chloride or sand blasting is often necessary. Methylene chloride is a hazardous chemical, and is not acceptable for flushing into storm drains. It should not be allowed to soak into the soil. Therefore, urethane removal is best handled by professionals.

Water Based Epoxy Sealers

Water based epoxy sealers combine other types of sealers with epoxy. They cure by chemical reaction as well as by evaporation. They have very fine solids allowing them to penetrate deep into concrete while still leaving a slight sheen to enhance the color of the pavers. They generally do not change the skid resistance of the surface. When applied, water based epoxy sealers create an open surface matrix that allows the paver surface to breathe thereby reducing the risk of trapping efflorescence under the sealer should it rise to the surface. They resist most chemicals and degradation from UV radiation. These characteristics make these types of sealers suitable for high use areas such as theme parks and shopping malls. The elasticity and adhesion of these sealers make them appropriate for heavily trafficked street projects and areas subject to aggressive cleaning practices.

SEALING PROCEDURES

All dirt, oil stains and efflorescence must be removed prior to sealing. The cleaned surface must be completely dry prior to applying most sealers. Allow at least 24 hours without moisture or surface dampness before application. The pavers may draw efflorescence to the surface, or the sealer or liquid stabilizer may whiten under any one of these conditions:

- The surface and joints are not dry
- The pavers have not had an adequate period of exposure to moisture
- There is a source of efflorescence under the pavers (i.e, in the sand, base, or soil) moving through the joint sand and/or pavers
- The sealer is not breathable, i.e., does not allow moisture to move through to the surface of the paver and evaporate.

If the base under the pavers drains poorly, the sealer is applied to saturated sand in the joints, or is applied too thick, the sealer can become cloudy and diminish the appearance of the pavers. In this situation, the sealer must be removed or re-dissolved. Consult your sealer supplier for advice on treating this situation.

Cover and protect all surfaces and vegetation around the area to be sealed. For exterior (low-pressure) sprayed applications, the wind should be calm so that it does not cause an uneven application, or blow the sealer onto other surfaces. For many sealers, especially those with high VOC's, wear protective clothing and mask recommended by the sealer manufacturer to protect the lungs and eyes.

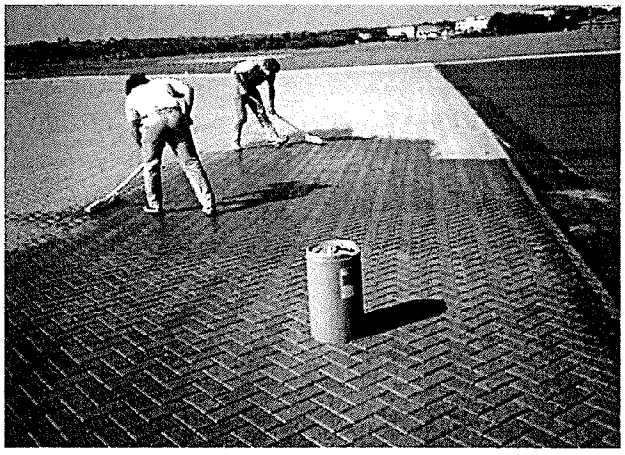


Figure 10. Urethane is applied with squeegees to stabilize joint sand between pavers on aircraft pavement.

Sealers can be applied with a hand roller if the area is small (under 1000 ft² or 100 m²). For larger areas, more efficient application methods include a powered roller, or a low pressure sprayer. Sealers are often applied with a foam roller to dry pavers having clean surfaces and chamfers. However, the use of a squeegee to spread the sealer will avoid pulling joint sand out of the joints. See Figure 10.

Sealer should be spread and allowed to stand in the chamfers, soaking into the joints. Penetration into the joint sand should be at least 3/4 inch (20 mm). The excess sealer on the surface is pushed to an unsealed area with a rubber squeegee. The action of a squeegee wipes most of the sealer from the surface of the pavers while leaving some remaining in the chamfers to eventually soak into the joints. Generally only one coat is required.

For other applications, follow the sealer manufacturer's recommendation for application and for the protective gear to be worn during the job. With some sealers that recommend two coats, the first coat is usually applied to saturation. A light second coat, if needed, can be applied for a glossy finish. Be careful not to over apply the sealers such that the surface becomes slippery when cured. For water based sealers requiring two coats, always apply the second coat while the first coat is still very tacky. Prevent all traffic from entering the area until the sealer is completely dry, typically 24 hours.

If spraying sealer on the pavers, care should be taken to prevent the spray nozzle from clogging and causing large droplets to be unevenly distributed on them. This is most important for water based sealers. This can cause a poor appearance and performance.

Sealers normally require reapplication after a period of wear and weather. The period of reapplication will depend on the use, climate, and quality of the sealer.

Safety Considerations

Adequate slip (foot) and skid (tire) resistance of concrete pavers should be maintained with properly applied joint sand stabilizer or surface sealers. See ICPI *Tech Spec 13 – Slip and Skid Resistance of Interlocking Concrete Pavements* for test methods and guidelines. See www.icpi.org to obtain this and all ICPI Tech Spec technical bulletins. The manufacturers of stabilization and sealers should be consulted concerning slip and skid resistance performance characteristics under wet and dry conditions.

Some commercial or industrial pavement use painted pavement markings. Consult with the stabilizer and sealer manufacturers for compatibility of their materials with pavement markings. Where there are pavement markings, applications using high gloss materials should be avoided as they can increase the difficulty of reading pavement markings under certain light conditions.

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Federal, state/provincial, and some municipal governments regulate building materials with high volatile organic contents (VOCs). The restrictions usually apply to solvent based sealers. The VOC level of a sealer refers to the pounds per gallon (or grams per liter) of solvent which evaporates from the sealer, excluding the water. VOCs have been regulated since they can contribute to smog. Most water based sealers comply with VOC restrictions and some solvent based products may comply as well. The user should check with the sealer supplier to verify VOC compliance in those areas that have restrictions.

Many solvent based products are combustible and emit hazardous fumes. Therefore, flame and sparks should be prevented in the area to be sealed. Never use solvent based sealers in poorly ventilated or confined areas.

Persons applying joint sand stabilizers and sealers should wear breathing and eye protection as recommended by the manufacturer, as well as protective equipment mandated by local, state/provincial, or federal safety agencies. Follow all label precautions and warnings concerning handling, storage, application, disposal of unused materials, and those required by all government agencies.

The U.S. Federal Government and Canadian Government require that all shipments of hazardous materials by common carrier must be accompanied by a Material Safety Data Sheet (MSDS). All chemical manufacturers must supply sheets to shippers, distributors and dealers of cleaners, joint sand stabilizers, and sealers if the materials are hazardous. The MSDS must accompany all shipments and be available to the purchaser on request. The MSDS lists the active ingredients, compatibility and incompatibility with other materials, safety precautions and an emergency telephone number if there is a problem in shipping, handling or use. The user should refer to the MSDS for this information.

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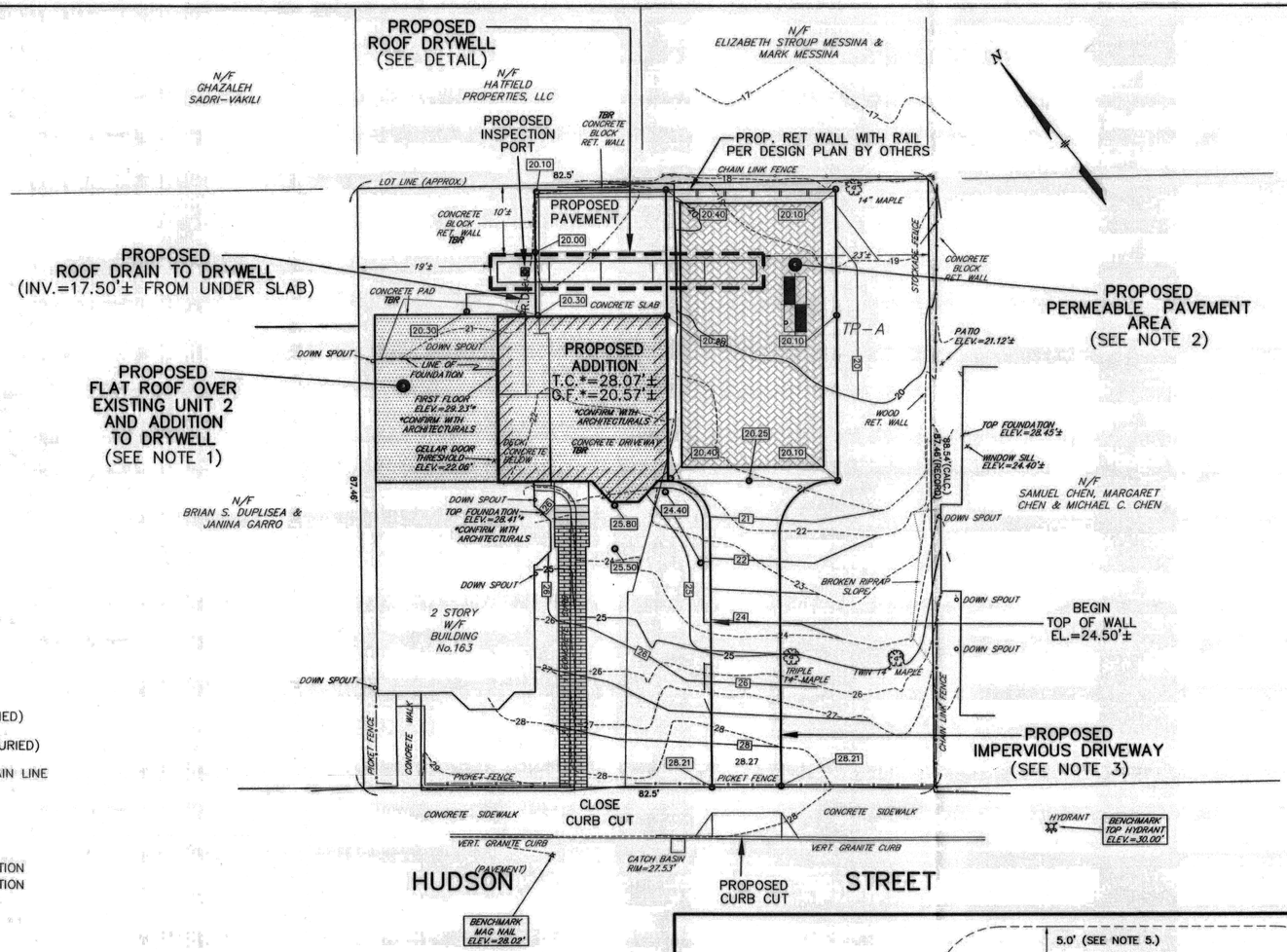


LEGEND:

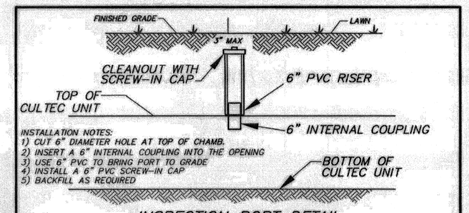
- N/F — NOW OR FORMERLY
- OHW — OVERHEAD WIRES
- TREE
- TREE LINE
- UP — UTILITY POLE
- GG* — GAS GATE
- G — GAS SERVICE (BURIED)
- WG* — WATER GATE
- W — WATER SERVICE (BURIED)
- DMH — DRAIN MANHOLE
- D — SUB-SURFACE DRAIN LINE
- LIGHTPOLE
- A.D. — AREA DRAIN
- R.D. — ROOF DRAIN
- × 21.12 — EXIST SPOT ELEVATION
- 20.40 — PROP SPOT ELEVATION
- T.C. — TOP OF CONCRETE
- G.F. — GARAGE FLOOR

DRAINAGE PLAN NOTES:

1. INTERNAL ROOF DRAIN TO BE CENTRALLY LOCATED WITHIN FLAT ROOF AREA WHICH WILL EXIT FROM ADDITION UNDER REAR OF SLAB FOUNDATION TO PROPOSED DRYWELL.
2. DESIGN OF PERMEABLE PAVEMENT AREA TO BE PROVIDED BY OTHERS. RAIL TO BE PROVIDED ALONG REAR LOT LINE.
3. GRADES OF PROPOSED DRIVEWAY ACCESS IS BASED ON ELEVATIONS OF EXISTING TOP OF FOUNDATION, PROPOSED ADDITION AND SIDEWALK GRADE AND ARE SUBJECT TO MINOR ADJUSTMENTS.
4. APPROPRIATE EROSION CONTROLS SHALL BE PROVIDED BY CONTRACTOR DURING CONSTRUCTION.
5. THE USE OF THIS PLAN IS FOR DRAINAGE PURPOSES ONLY FOR THE DESIGN AND CONSTRUCTION OF THE PROPOSED ROOF DRYWELL. LOT LINES ARE APPROXIMATE ONLY. BUILDER AND CONTRACTOR SHALL CONFIRM ADDITION ELEVATIONS AND PERMEABLE PAVEMENT DESIGN PRIOR TO INSTALLATION OF DRAINAGE COMPONENTS. CONTACT ENGINEER WITH ANY PLAN DEVIATIONS PRIOR TO INSTALLATION.
6. PROPOSED DRAINAGE SYSTEM IS SUBJECT TO AN OPERATION & MAINTENANCE PLAN WHICH HAS BEEN PROVIDED WITHIN THE STORMWATER REPORT.

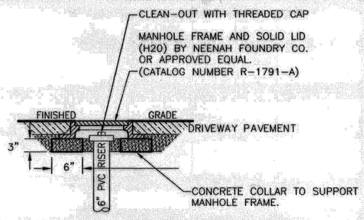
UTILITY NOTE:

ALL UNDERGROUND UTILITIES SHOWN HERE WERE COMPILED ACCORDING TO AVAILABLE RECORD PLANS FROM VARIOUS UTILITY COMPANIES AND PUBLIC AGENCIES AND ARE APPROXIMATE ONLY. ACTUAL LOCATIONS MUST BE DETERMINED IN THE FIELD BEFORE DESIGNING, EXCAVATING, BLASTING, INSTALLING, BACKFILLING, GRADING, PAVEMENT RESTORATION OR REPAIRING. ALL UTILITY COMPANIES, PUBLIC AND PRIVATE, MUST BE CONTACTED INCLUDING THOSE IN CONTROL OF UTILITIES NOT SHOWN ON THIS PLAN. SEE CHAPTER 370., ACTS OF 1963 MASS. WE ASSUME NO RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN. BEFORE PLANNING FUTURE CONNECTIONS, THE APPROPRIATE PUBLIC UTILITY ENGINEERING DEPARTMENT MUST BE CONSULTED. DIG SAFE TELE. NO. 1-888-344-7233.



INSPECTION PORT DETAIL

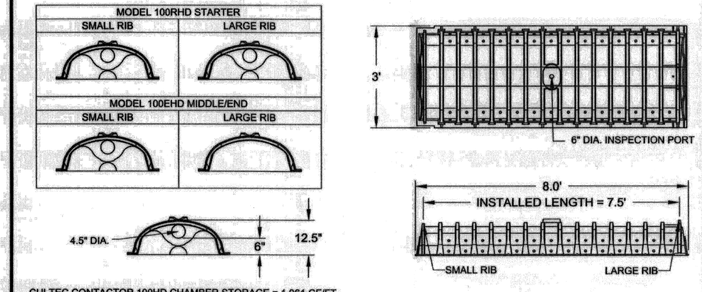
N.T.S.



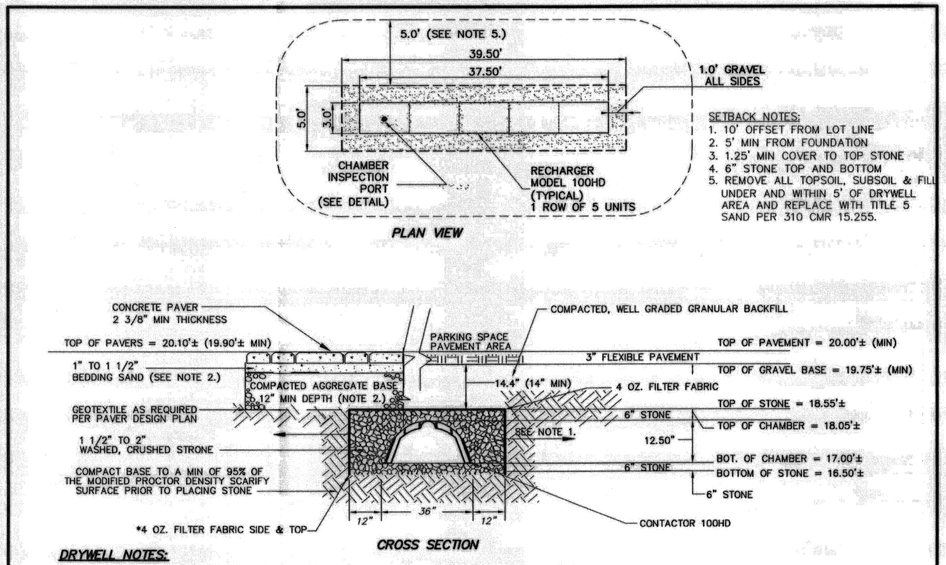
INSPECTION PORT IN PAVEMENT DETAIL

N.T.S.

CULTEC RECHARGER 100HD HEAVY DUTY (ROOF DRYWELL)



CULTEC CONTACTOR 100HD CHAMBER STORAGE = 1.961 CF/FT
INSTALLED LENGTH ADJUSTMENT = 0.5'
ALL CONTACTOR 100HD HEAVY DUTY UNITS ARE MARKED WITH A COLOR STRIPE FORMED INTO THE PART ALONG THE LENGTH OF THE CHAMBER.



SETBACK NOTES:
1. 10' OFFSET FROM LOT LINE
2. 5' MIN FROM FOUNDATION
3. 1.25' MIN COVER TO TOP STONE
4. 6" STONE TOP AND BOTTOM
5. REMOVE ALL TOPSOIL, SUBSOIL & FILL UNDER AND WITHIN 5' OF DRYWELL AREA AND REPLACE WITH TITLE 5 SAND PER 310 CMR 15.255.

DRYWELL NOTES:

1. REMOVE REMNANT FOOTINGS, FOUNDATIONS TOP SOIL, SUBSOIL AND FILL BELOW & WITHIN 5' OF DRYWELL AREAS. REPLACE WITH SEPTIC SAND IN ACCORDANCE WITH 310 CMR 15.255.
2. OWNER SHALL CONFIRM WITH PERMEABLE PAVER DESIGNER THAT 12" AGGREGATE BASE IS SUITABLE FOR INTENDED USE PRIOR TO CONSTRUCTION. PAVER MATERIALS AND DEPTHS SHOWN ON THIS PLAN ARE FOR GUIDANCE PURPOSESE ONLY FOR DESIGN OF ROOF DRYWELL. THE DESIGN OF THE PERMEABLE PAVER AREA IS NOT PART OF THIS DRAINAGE PLAN, AND SAID DESIGN SHALL BE PROVIDED BY OTHERS.
3. RECOMMEND INSTALL OF PERMEABLE PAVERS PER GUIDANCE OF INTERLOCKING CONCRETE PAVEMENT INSTITUTE.

DRYWELL DETAIL

N.T.S.

163 HUDSON STREET
SOMERVILLE, MA
(MIDDLESEX COUNTY)

GRADING AND DRAINAGE PLAN

FOR: GOGUEN

SCALE: 1"=10' NOVEMBER 16, 2010

STAMSKI AND McNARY, INC.
1000 MAIN STREET ACTON, MASS.
ENGINEERING - PLANNING - SURVEYING
978-263-8585

SM-4729 (4729 DRAINAGE PLAN.DWG)

COMMONWEALTH OF MASSACHUSETTS
JOSEPH MARCH
CIVIL
#40472
REGISTERED PROFESSIONAL ENGINEER