CITY OF HAVERHILL
CITY COUNCIL AGENDA
Tuesday, August 24, 2021 at 7:00 PM
Theodore A. Pelosi, Jr. Council Chambers, 4 Summer st, Room 202
In-Person/Remote Meeting

This meeting/hearing of Haverhill City Council will be held in-person at the location provided on this notice. Members of the public are welcome to attend this in-person meeting. Please note that while an option for remote attendance and/or participation is being provided as a courtesy to the public, the meeting/hearing will not be suspended or terminated if technological problems interrupt the virtual broadcast, unless otherwise required by law. Members of the public with particular interest in any specific item on this agenda should make plans for in-person vs. virtual attendance accordingly.

1. **OPENING PRAYER**
2. **PLEDGE OF ALLEGIANCE**
3. **APPROVAL OF MINUTES OF PRIOR MEETING**
4. **ASSIGNMENT OF THE MINUTES REVIEW FOR THE NEXT MEETING**
5. **COMMUNICATIONS FROM THE MAYOR:**
6. **COMMUNICATIONS FROM COUNCILLORS TO INTRODUCE AN INDIVIDUAL(S) TO ADDRESS THE COUNCIL:**
7. **PUBLIC PARTICIPATION- REQUESTS UNDER COUNCIL RULE 28**
8. **COMMUNICATIONS AND REPORTS FROM CITY OFFICERS AND EMPLOYEES**:

    8.1. Communication from Linda Koutoulas, City Clerk, announcing early voting before our preliminary election being held on September 14, 2021; to be held in person in City Hall basement (former RMV location) from Tuesday, September 7th through Friday, September 10th, from 8-4 and on Thursday, September 9th, from 8-8pm. Also recommends early voting to be held on Sunday, September 5th from 2:30-8 pm at *Somebody Cares*, located at 358 Washington st

    8.2. Abatement report from Christine Webb, Assessor for the month of July 2021

9. **UTILITY HEARING(S) AND RELATED ORDER(S)**:
10. **HEARINGS AND RELATED ORDERS:**

    10.1. Document 32-C : Application from Attorney Robert Harb for client Solar Smart LLC for CCSP-21-8 Solar Energy System Special Permit for Large Scale Ground Mounted Solar Energy System at 139 Amesbury Line rd

    10.2. Document 32-D: Application from Attorney Robert Harb for client Solar Smart LLC for CCSP-21-9 Solar Energy System Special Permit for Large Scale Ground Mounted Solar Energy System at 139 Amesbury Line rd; in Water Supply Protection Overlay District (WSPOD) Comments are included

    Hearings postponed from June 15 2021

11. **APPOINTMENTS:**

    11.1. **Confirming Appointments:**

    11.2. **Non-Confirming Appointments :**

    11.2.1. ***Mayor's Task Force on Public Health*:**

    Kevin McCarthy of Groundwork Lawrence

    Tony Slabacheski, Holy Family Hospital, Haverhill Campus, Administrator in Charge

    To Expire December 31 2021

    11.3. **Resignations:**

12. PETITIONS:

12.1. **Applications Handicap Parking Sign**

12.2. **Amusement/Event Applications:**

12.3. **Tag Day**
12.4. **One Day Liquor License:**
12.5. **Annual License Renewals:**
12.5.1. **Hawker Peddlers License 2021 - Fixed location**
12.5.2. **Coin-Op License Renewals 2021**
12.5.3. **Drainlayer License for 2021 - with City Engineer approval**
12.5.4. **Christmas Tree Vendor**

12.5.5. **Taxi Driver Licenses for 2021**
12.5.5.1. Michael Brown, Manchester, NH – *new* **Denied** by Police

12.5.6. **Taxi License/ Limo/Livery**
12.5.7. **Junk Dealer License**
12.5.8. **Pool Tables**
12.5.9. **Sunday Pool**
12.5.10. **Bowling**
12.5.11. **Sunday Bowling**
12.5.12. **Buy & Sell Second Hand Articles**
12.5.13. **Buy & Sell Second Hand Clothing**
12.5.14. **Pawnbroker license**
12.5.15. **Fortune Teller**
12.5.16. **Buy & Sell Old Gold**
12.5.17. **Roller Skating Rink**
12.5.18. **Sunday Skating**
12.5.19. **Exterior Vending Machines – 2021 renewals**
12.5.20. **Limousine/Livery License/Chair Cars**

13. Motions and Orders:

13.1. Order – Precinct Officers in the several wards of the City for the year 2021

14. Communications from Councillors:

14.1. Communication from Councillor Daly O'Brien requesting to discuss closing Washington st and Wingate st on Friday and Saturday evenings making them pedestrian only

14.2. Communication from Councillor Daly O'Brien requesting to discuss a constituent's request to put an end to commercial truck traffic on Mill st and the issue of truck traffic through residential neighborhoods throughout the City

14.3. Communication from Councillor Joseph Bevilacqua requesting to discuss the opportunity for additional senior citizen housing

14.4. Communication from Councillor Joseph Bevilacqua requesting to recognize the 20th Anniversary Commemoration of the September 11, 2001 terrorist attacks

14.5. Communication from Councillor Daly O'Brien and Councillor Bevilacqua requesting to discuss the continuing neighborhood concerns with NETTS tractor trailer traffic on Monument st

15. Unfinished Business Of Preceding Meeting

16. RESOLUTIONS and PROCLAMATIONS

17. Council Committee Reports and Announcements

18. Documents referred to committee study

19. Long term matters study list

20. Adjourn

(811)

Haverhill

City Clerk's Office, Room 118
Phone: 978-374-2312 Fax: 978-373-8490
cityclerk@cityofhaverhill.com

August 20, 2021

Council President Barrett and Members of the City Council

RE: Early Voting in person

Dear President Barrett and Councillors:

As you are aware, the City will hold a preliminary election on September 14 2021. The Massachusetts Legislature has passed legislation allowing cities and towns holding municipal elections to conduct early voting this year, in person or by mail, before September 14th.

It is my recommendation that early voting be held in person in City Hall basement (former RMV location) from Tuesday, September 7 through Friday, September 10, from 8-4 and on Thursday, September 9, from 8-8PM. Additionally, I also recommend early voting be held on Sunday, September 5 from 2:30-8PM at Somebody Cares, located at 358 Washington St.

I request the Council's approval for this request.

Sincerely,

Linda L Koutoulas
Haverhill City Clerk

8.2

CITY OF HAVERHILL

ASSESSORS OFFICE – ROOM 115
Phone: 978-374-2316 Fax: 978-374-2319
Assessors@cityofhaverhill.com

Aug.13,2021

TO: MEMBERS OF THE HAVERHILL CITY COUNCIL:

In accordance with Municipal Ordinance, Chapter 7, entitled "Assessor" as follows:

The Board of Assessors shall file monthly with the City Council a copy of the report submitted to the Auditor showing a summary of the above abated amounts for that month.

Attached herewith is the report for the month of July as filed in the Assessors Office.

Very truly yours,

Christine Webb, MAA
Assessor

Transaction Summary All Years

City of Haverhill

All Entry Date range 07/01/2021 through 07/31/2021 for Abatements

Totals	Tax Paid	Interest Paid	Fees Paid	Tax Reversals	Interest Reversals	Fee Reversals	Refunds	Refund Reversals	Abate	Exemp	Adjust	Transfers
Motor Vehicle Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	261.25	0.00	0.00	0.00
2017 Motor Vehicles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	261.25	0.00	0.00	0.00
2017	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**261.25**	**0.00**	**0.00**	**0.00**
Boat Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00
2018 Boats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00
2018	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**25.00**	**0.00**	**0.00**	**0.00**
Motor Vehicle Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	138.72	0.00	0.00	0.00
2019 Motor Vehicles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	138.72	0.00	0.00	0.00
2019	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**138.72**	**0.00**	**0.00**	**0.00**
Boat Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00
2020 Boats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00
Motor Vehicle Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	632.37	0.00	0.00	0.00
2020 Motor Vehicles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	632.37	0.00	0.00	0.00
Personal Property Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13,289.58	0.00	0.00	0.00
2020 Personal Property	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13,289.58	0.00	0.00	0.00
Property Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,730.88	0.00	0.00	0.00
2020 Real Estate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,730.88	0.00	0.00	0.00
2020	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**16,677.83**	**0.00**	**0.00**	**0.00**
Boat Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	585.00	0.00	0.00	0.00
2021 Boats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	585.00	0.00	0.00	0.00
Motor Vehicle Excise Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22,525.34	0.00	0.00	0.00
2021 Motor Vehicles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22,525.34	0.00	0.00	0.00
Personal Property Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	476.21	0.00	0.00	0.00
2021 Personal Property	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	476.21	0.00	0.00	0.00

Transaction Summary All Years

City of Haverhill

All Entry Date range 07/01/2021 through 07/31/2021 for Abatements

Totals	Tax Paid	Interest Paid	Fees Paid	Tax Reversals	Interest Reversals	Fee Reversals	Refunds	Refund Reversals	Abate	Exemp	Adjust	Transfers
Property Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,698.75	0.00	0.00	0.00
2021 Real Estate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,698.75	0.00	0.00	0.00
2021	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**26,285.30**	**0.00**	**0.00**	**0.00**
Report	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**43,388.10**	**0.00**	**0.00**	**0.00**

Total All Charges **43,388.10**

Total All Charges: Add all columns except Adjustments.

CCSP-21-8

32-C

Hearing June 15, 2021

32C

ROBERT D. HARB
ATTORNEY AT LAW
17 WEST STREET
HAVERHILL, MASSACHUSETTS 01830

10.1

TEL: (978) 373-5611
FAX: (978) 373-7441
EMAIL: bobharb@aol.com

Of Counsel
Alfred J. Cirome

April 8, 2021

City of Haverhill
City Council
4 Summer Street, Haverhill, MA 01830

RE: 139 Amesbury Line Road:

Application For Solar Energy System Special Permit and Water Supply Protection District (WSPD) Special Permit

Dear City Council:

On behalf of the Applicant and Lessee, Solar Smart LLC, application is hereby made for a Special Permit for Large Scale Ground Mounted Solar Energy System in accordance with the City Zoning Ordinance (see Sections 7.8 and following).

Application is also made for a Special Permit for the installation of this solar energy system within the Water Supply Protection District in accordance with the City Zoning Ordinance (See Section 9.2.7).

Reference is hereby made to all the Plans and Specifications filed with this Application as well as the written testimony of Kyle Burchard, P.E. also filed with this Application and incorporated herein by reference

Financial Surety for this Large Scale Ground Mounted Solar Energy System project has been reviewed with the Planning Director and will be filed if this Special permit is approved during the Appeal period.

Applicant, based upon the testimony, plans and evidence submitted herewith and supplemented at the Public Hearing, respectfully requests the City Council to make a written determination and find that:

1. The proposed use or structure(s) shall not cause substantial detriment to the neighborhood or the City, taking into account the characteristics of the site and of the proposal in relation to that site.
2. The grant of a special permit for a large-scale ground-mounted solar energy system will promote the highest and best use of the subject property, taking into account the characteristics of the

32-C 21-96
CCSP

subject property, including past land uses, possible presence of hazardous materials, and other development limitations.

3. There are Community energy needs which are served by this Project.
4. There is safe traffic and pedestrian flow provided by this Project.
5. There are adequate utilities and other public services for this Project.
6. The Natural Environment will not be impacted.
7. There is no impact on City services and this project will increase the city tax base.

In addition to meeting the above, the Council can also find that the proposed use:

1. Satisfies the design and operations guidelines set forth in the Zoning Ordinance;
2. Is in harmony with the purposes and intent of this Section and will promote the purposes of the WSPD;
3. Is appropriate to the natural topography, soils, and other characteristics of the site to be developed;
4. Will not, during construction or thereafter, have an adverse environmental impact on any water body or watercourse in the district; and 5. Will not adversely affect the quality or quantity of an existing water supply.

The Applicant respectfully requests Council approval of both the Solar Energy System Special Permit and The Water Supply Protection District (WSPD) Special Permit.

Respectfully submitted

Robert D. Harb Attorney for Solar Smart LLC

Robert D. Harb, Attorney for Solar Smart LLC

IN CITY COUNCIL: April 27 2021
VOTED: that HEARING BE HELD JUNE 15 2021
Attest:
______________________Acting City Clerk

IN CITY COUNCIL: June 15 2021
POSTPONED TO AUGUST 24 2021
Attest : ________________________City Clerk

ROBERT D. HARB
ATTORNEY AT LAW
17 WEST STREET
HAVERHILL, MASSACHUSETTS 01830

TEL: (978) 373-5611
FAX: (978) 373-7441
EMAIL:

Of Counsel
Alfred J. Cirome

2021 JUN 15 AM 09:39 HAV. CITY CLERK

June 15, 2021

City of Haverhill
Haverhill City Council
4 Summer Street, Haverhill, MA 01830

CCSP 21-8

Delivered In Hand

RE: 139 Amesbury Line Road: Special Permit Hearings: CCSP-21- 8 and CCSP-21-9

Request For Continuance

CCSP-21-8 Application For Special Permit For Large Scale Ground Mounted Solar Energy System and
CCSP-21-9 - Application For Special Permit for Installation of a Large Scale Ground Mounted Solar energy System in the Water Supply Protection Overlay District (WSPOD)

Dear City Council:

On behalf of the Applicant and Lessee, Solar Smart LLC, request is hereby made for a continuance of the hearings for the above two Special Permit Hearing until August 24, 2021.

Applicant has been diligently working with all City Departments, including Fire, Conservation and Water Departments, and the abutters prior to and after filing the above Applications. There remain a few outstanding items that are moving towards a resolution; thus, this request for a continuance to allow the applicant the time to resolve these items.

This is Applicant's first request for a continuance.

Applicant hereby waives the 120-day hearing requirement.

Respectfully submitted,

Robert D. Harb

Robert D. Harb, Attorney for Solar Smart LLC

Ce88 - 21 - 9

32-D

10.2

ROBERT D. HARB

ATTORNEY AT LAW
17 WEST STREET
HAVERHILL, MASSACHUSETTS 01830

TEL: (978) 373-5611
FAX: (978) 373-7441
EMAIL: bobharb@aol.com

Of Counsel
Alfred J. Cirome

April 8, 2021

City of Haverhill
City Council
4 Summer Street, Haverhill, MA 01830

RE: 139 Amesbury Line Road:

Application For Solar Energy System Special Permit and Water Supply Protection District (WSPD) Special Permit

Dear City Council:

On behalf of the Applicant and Lessee, Solar Smart LLC, application is hereby made for a Special Permit for Large Scale Ground Mounted Solar Energy System in accordance with the City Zoning Ordinance (see Sections 7.8 and following).

Application is also made for a Special Permit for the installation of this solar energy system within the Water Supply Protection District in accordance with the City Zoning Ordinance (See Section 9.2.7).

Reference is hereby made to all the Plans and Specifications filed with this Application as well as the written testimony of Kyle Burchard, P.E. also filed with this Application and incorporated herein by reference

Financial Surety for this Large Scale Ground Mounted Solar Energy System project has been reviewed with the Planning Director and will be filed if this Special permit is approved during the Appeal period.

Applicant, based upon the testimony, plans and evidence submitted herewith and supplemented at the Public Hearing, respectfully requests the City Council to make a written determination and find that:

1. The proposed use or structure(s) shall not cause substantial detriment to the neighborhood or the City, taking into account the characteristics of the site and of the proposal in relation to that site.
2. The grant of a special permit for a large-scale ground-mounted solar energy system will promote the highest and best use of the subject property, taking into account the characteristics of the

32-D

subject property, including past land uses, possible presence of hazardous materials, and other development limitations.

3. There are Community energy needs which are served by this Project.
4. There is safe traffic and pedestrian flow provided by this Project.
5. There are adequate utilities and other public services for this Project.
6. The Natural Environment will not be impacted.
7. There is no impact on City services and this project will increase the city tax base.

In addition to meeting the above, the Council can also find that the proposed use:

1. Satisfies the design and operations guidelines set forth in the Zoning Ordinance;
2. Is in harmony with the purposes and intent of this Section and will promote the purposes of the WSPD;
3. Is appropriate to the natural topography, soils, and other characteristics of the site to be developed;
4. Will not, during construction or thereafter, have an adverse environmental impact on any water body or watercourse in the district; and 5. Will not adversely affect the quality or quantity of an existing water supply.

The Applicant respectfully requests Council approval of both the Solar Energy System Special Permit and The Water Supply Protection District (WSPD) Special Permit.

Respectfully submitted

Robert D. Harb Attorney for Solar Smart LLC

Robert D. Harb, Attorney for Solar Smart LLC

IN CITY COUNCIL: April 27 2021
VOTED THAT COUNCIL HEARING BE HELD
JUNE 15 2021
Attest:
____________________________Acting City Clerk

IN CITY COUNCIL: June 15 2021
POSTPONED TO AUGUST 24 2021
ATTEST:______________________City Clerk

City of Haverhill, MA

08/18/2021

CCSP-21-8

City Council Special Permit

Status: Active

Date Created: Apr 13, 2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Important: Please Read Before Starting Your Application

Applicant Information

What Is Your Role in This Process?
Attorney/Agent

Applicant Business/Firm Name
Attorney Robert D Harb

Applicant Business/Firm Phone
9783735611

Applicant Business/Firm Address
17 West Street

Applicant Business/Firm City
Haverhill

Applicant Business/Firm State
MA

Applicant Business/Firm Zip
01830

Client Name
Solar Smart LLC

Client Business Name
Solar Smart LLC

Client Phone
843-743-9180

Client Email
peterr@solarsmartllc.com

Client Address
1207 Congressional Blvd.

Client City
Sommerville

Client State
SC

Client Zip
29483

Client County
Dorchester

Client Business Structure
Limited Liability Corporation (LLC)

Property Information

Proposed Housing Plan Name
Solar Photovoltaic Project

Proposed Street Name(s)
N/A

How Long Owned by Current Owner?
13 years more or less

Type of Dwelling(s) Planned in Project
Single Family

Lot Dimension(s)
583+feet frontage :718.27+ mean depth; and 26.813 acres

Registry Plat Number, Block & Lot
430-11-12

Zoning District Where Property Located
RS - Residential Rural Special

--

Deed Recorded in Essex South Registry: Block Number
27892

Deed Recorded in Essex South Registry: Page
453

Does the Property Have Multiple Lots?
No

IF YES, How Many Lots?
1

IF YES, What Is/Are the Map, Block Lot (MBL) Number(s)?
--

Thoroughly Describe the Reason(s) for thre Special Permit
Applicant Seeks a Large Scale Ground Mounted Solar Energy System Special Permit

Property Description
See Plans and bounded description filed herewith for property description. Note: Portion of property is also in an RM Zone.

Current Property Use
Residential Housing

TOTAL Number of Units Planned
0

TOTAL Number of Parking Spaces Planned
0

Special Circumstances

Building Coverage
☐

Dimensional Variance
☐

Front Yard Setback
☐

Side Yard Setback
☐

Rear Yard Setback
☐

Lot Frontage
☐

Lot Depth
☐

Lot Area
☐

Building Height
☐

Floor Area Ratio
☐

Open Space
☐

Parking
☐

Sign Size
☐

Use
☐

Other
☑

IF OTHER, Please Describe
Solar Energy System Special Permit and Water Supply Protection District (WSPD) Special Permit

Hearing Waiver

Agrees
No

Agreement & Signature

Agrees
☑

PLEASE READ

Office Use Only

City Council Decision

--

City Council Hearing Date

--

Reason for Council's Decision

--

City Council Members Absent

--

City Council Members Present

--

Continuance Meeting Date

--

Also Present

--

City Councilor Who Seconded Motion

--

City Councilor Who Made Motion

--

City Councilors Who Voted Against

--

City Councilors Who Abstained

--

Continuance Motion Decision

--

Who Submitted Continuance Request?

--

City Councilors Who Voted in Favor

--

Number of 12"x18" Mylar Copies

--

Appeal Expiration Date

--

Number of 24"x36" Mylar Copies

--

Number of 18"x24" Mylar Copies

--

Attachments

pdf ted x assent.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:16 pm

pdf _Haverhill Solar CC Special Permit Application Letter.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:22 pm

docx Planning Board decision not required for Application.docx
Uploaded by Robert Harb on Apr 8, 2021 at 10:49 pm

docx Approved Site Plan not required for Application.docx
Uploaded by Robert Harb on Apr 8, 2021 at 10:49 pm

pdf xenakis-plan-image - 2021-04-08T220120.941.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:23 pm

pdf solar app-c.pdf
Uploaded by Robert Harb on Apr 13, 2021 at 12:08 pm

pdf ccsp 21 9 gpr.pdf
Uploaded by LINDA KOUTOULAS on Apr 16, 2021 at 11:44 am

pdf _Haverhill Solar Site Plan Set 2021.04.08.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:34 pm

pdf Appendix1-Solar Farm Components.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:31 pm

pdf Appendix2-SWM Report and O&M.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:35 pm

pdf Appendix3-Solar Facility O&M.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:31 pm

pdf Appendix4-ConstructionAccessAgreement.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:30 pm

pdf Appendix5-Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV Rev6-E-1).pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:30 pm

pdf Appendix6-Solar Site Illustratives.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 10:31 pm

PDF Appendix7-Whittier School Sewer Plan.PDF
Uploaded by Robert Harb on Apr 8, 2021 at 10:44 pm

pdf solar control.pdf
Uploaded by Robert Harb on Apr 8, 2021 at 11:01 pm

pdf solar description.pdf
Uploaded by Robert Harb on Apr 13, 2021 at 12:09 pm
csv Abutters 139 Amesbury Line Rd 430.11.12.csv
Uploaded by Christine Webb on Apr 16, 2021 at 1:00 pm
pdf Mailing Labels 139 Amesbury Line Rd 430.11.12.pdf
Uploaded by Christine Webb on Apr 16, 2021 at 1:00 pm
pdf 06-15-21 CCSP-8 solar 139 Amesbury Line.pdf
Uploaded by LINDA KOUTOULAS on May 6, 2021 at 2:57 pm
doc Beekeeper Request.doc
Uploaded by Robert Harb on May 24, 2021 at 1:26 pm
pdf 20210602_33-1499_CEIStormwaterPeerReview1.pdf
Uploaded by Robert Moore on Jun 11, 2021 at 12:46 pm
pdf Haverhill Solar AMENDED CC Special Permit Application Letter 2021.08.16.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 6:31 pm
pdf _Haverhill Solar AMENDED Site Plan Set 2021.08.16.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 6:53 pm
pdf Appendix1-AMENDED Solar Farm Components.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 6:40 pm
pdf Appendix1-AMENDED Solar Farm Components.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 6:39 pm
pdf Appendix2-AMENDED SWM Report and O&M.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 6:44 pm
pdf Appendix3-Solar Facility O&M.pdf
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pdf Appendix4-ConstructionAccessAgreement.pdf
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pdf Appendix5-AMENDED Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV One-Line Rev9-E-1).pdf
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PDF Appendix7-Whittier School Sewer Plan.PDF
Uploaded by Robert Harb on Aug 17, 2021 at 6:58 pm
pdf Appendix8-AMENDED Haverhill Fire Department Cart Path Proposal.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 6:42 pm
doc Solar-2021.08.16 189 Amesbury Line Rd - Special Permit Comments and RESPONSES.docx
Uploaded by Robert Harb on Aug 17, 2021 at 6:40 pm

History

Date	Activity
Apr 8, 2021 at 9:47 pm	Robert Harb started a draft of Record CCSP-21-8
Apr 8, 2021 at 10:24 pm	Robert Harb added attachment _Haverhill Solar Site Plan Set 2021.04.08.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:28 pm	Robert Harb added attachment Appendix1-Solar Farm Components.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:28 pm	Robert Harb added attachment Appendix2-SWM Report and O&M.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:29 pm	Robert Harb added attachment Appendix3-Solar Facility O&M.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:29 pm	Robert Harb added attachment Appendix3-Solar Facility O&M.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:29 pm	Robert Harb added attachment Appendix4-ConstructionAccessAgreement.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:29 pm	Robert Harb added attachment Appendix5-Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV Rev6-E-1).pdf to Record CCSP-21-8
Apr 8, 2021 at 10:30 pm	Robert Harb added attachment Appendix6-Solar Site Illustratives.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:30 pm	Robert Harb added attachment Appendix6-Solar Site Illustratives.pdf to Record CCSP-21-8
Apr 8, 2021 at 10:30 pm	Robert Harb added attachment Appendix7-Whittier School Sewer Plan.PDF to Record CCSP-21-8
Apr 8, 2021 at 10:37 pm	Robert Harb removed attachment Appendix3-Solar Facility O&M.pdf from Record CCSP-21-8
Apr 8, 2021 at 10:37 pm	Robert Harb removed attachment Appendix6-Solar Site Illustratives.pdf from Record CCSP-21-8
Apr 8, 2021 at 11:01 pm	Robert Harb added attachment solar control.pdf to Record CCSP-21-8
Apr 13, 2021 at 12:09 pm	Robert Harb added attachment solar description.pdf to Record CCSP-21-8
Apr 13, 2021 at 12:11 pm	Robert Harb submitted Record CCSP-21-8
Apr 13, 2021 at 12:33 pm	completed payment step Special Permit Filing Fee on Record CCSP-21-8
Apr 13, 2021 at 12:33 pm	approval step Building Inspector Review was assigned to Tom Bridgewater on Record CCSP-21-8
Apr 13, 2021 at 12:33 pm	approval step Planning Director Review was assigned to William Pillsbury on Record CCSP-21-8
Apr 13, 2021 at 12:33 pm	approval step City Clerk Review - Hearing Dates Set was assigned to Maria Bevilacqua on Record CCSP-21-8
Apr 13, 2021 at 12:57 pm	LINDA KOUTOULAS assigned approval step City Council Clerk Notified to LINDA KOUTOULAS on Record CCSP-21-8
Apr 13, 2021 at 12:58 pm	LINDA KOUTOULAS assigned approval step Assessor for Abutter's List to Christine Webb on Record CCSP-21-8
Apr 13, 2021 at 12:58 pm	LINDA KOUTOULAS assigned approval step Conservation Department Review to Robert Moore on Record CCSP-21-8

City of Haverhill, MA

08/18/2021

CCSP-21-9

City Council Special Permit

Status: Active

Date Created: Apr 15, 2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Important: Please Read Before Starting Your Application

Applicant Information

What is Your Role in This Process?
Attorney/Agent

Applicant Business/Firm Name
Attorney Robert D Harb

Applicant Business/Firm Phone
19783735611

Applicant Business/Firm Address
17 West Street

Applicant Business/Firm City
Haverhill

Applicant Business/Firm State
MA

Applicant Business/Firm Zip
01830

Client Name
SOLAR SMART LLC

Client Business Name
SOLAR SMART LLC

Client Phone
843-743-9180

Client Email
PETERR@SOLARSMARTLLC.COM

Client Address
1207 CONGRESSIONAL BLVD

Client City
SOMMERVILLE

Client State
SC

Client Zip
29483

Client County
DORCHESTER

Client Business Structure
Limited Liability Corporation (LLC)

Property Information

Proposed Housing Plan Name
SOLAR PHOTOVOLTAIC PROJECT

Proposed Street Name(s)
N/A

How Long Owned by Current Owner?
13 YEARS MORE OR LESS

Type of Dwelling(s) Planned in Project
Single Family

Lot Dimension(s)
583+feet frontage ;718.27+ mean depth; and 26.813 acres

Registry Plat Number, Block & Lot
430-11-12

Zoning District Where Property Located
WSPD - Water Supply Protection District

--

Deed Recorded in Essex South Registry: Block Number
27892

Deed Recorded in Essex South Registry: Page
453

Does the Property Have Multiple Lots?
No

IF YES, How Many Lots?
1

IF YES, What Is/Are the Map, Block Lot (MBL) Number(s)?
--

Thoroughly Describe the Reason(s) for thre Special Permit
WATER SUPPLY PROTECTION OVERLAY DISTRICT (WSPOD) SPECIAL PERMIT FOR INSTALLATION OF A LARGE SCALE GROUND MOUNTED SOLAR ENERGY STSTEM IN THE WSPOD.

Property Description
SEE PLANS AND BOUNDED DESCRIPTION FILED HEREWITH FOR PROPERTY DESCRIPTION . nOTE PROPERTY ALOS INCLIDED IN RS AND RM UNDERLYING ZONES

Current Property Use
Residential Housing

TOTAL Number of Units Planned
0

TOTAL Number of Parking Spaces Planned
0

Special Circumstances

Building Coverage
☐

Dimensional Variance
☐

Front Yard Setback
☐

Side Yard Setback
☐

Rear Yard Setback
☐

Lot Frontage
☐

Lot Depth
☐

Lot Area
☐

Building Height
☐

Floor Area Ratio
☐

Open Space
☐

Parking
☐

Sign Size
☐

Use
☐

Other
☑

IF OTHER, Please Describe
Water Supply Protection District Overlay (WSPOD) Special Permit

Hearing Waiver

Agrees
No

Agreement & Signature

Agrees
☑

PLEASE READ

Office Use Only

City Council Decision

--

City Council Hearing Date

--

Reason for Council's Decision

--

City Council Members Absent

--

City Council Members Present

--

Continuance Meeting Date

--

Also Present

--

City Councilor Who Seconded Motion

--

City Councilor Who Made Motion

--

City Councilors Who Voted Against

--

City Councilors Who Abstained

--

Continuance Motion Decision

--

Who Submitted Continuance Request?

--

City Councilors Who Voted in Favor

--

Number of 12"x18" Mylar Copies

--

Appeal Expiration Date

--

Number of 24"x36" Mylar Copies

--

Number of 18"x24" Mylar Copies

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Attachments

pdf ted x assent.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:26 pm

pdf _Haverhill Solar CC Special Permit Application Letter.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:28 pm

docx Planning Board decision not required for Application.docx
Uploaded by Robert Harb on Apr 15, 2021 at 7:29 pm

docx Approved Site Plan not required for Application.docx
Uploaded by Robert Harb on Apr 15, 2021 at 7:29 pm

pdf xenakis-plan-image - 2021-04-08T220120.941.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:30 pm

pdf solar application.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:35 pm

pdf _Haverhill Solar Site Plan Set 2021.04.08.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:48 pm

pdf Appendix1-Solar Farm Components.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:46 pm

pdf Appendix2-SWM Report and O&M.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:50 pm

pdf Appendix3-Solar Facility O&M.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:46 pm

pdf Appendix4-ConstructionAccessAgreement.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:45 pm

pdf Appendix5-Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV Rev6-E-1).pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:45 pm

pdf Appendix6-Solar Site Illustratives.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:47 pm

PDF Appendix7-Whittier School Sewer Plan.PDF
Uploaded by Robert Harb on Apr 15, 2021 at 8:02 pm

pdf solar control.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:48 pm

pdf

solar description.pdf
Uploaded by Robert Harb on Apr 15, 2021 at 7:49 pm

pdf ccsp 21 9 gpr.pdf
Uploaded by LINDA KOUTOULAS on Apr 16, 2021 at 11:41 am

csv Abutters 139 Amesbury Line Rd 430.11.12.csv
Uploaded by Christine Webb on Apr 22, 2021 at 8:05 am

pdf Mailing Labels 139 Amesbury Line Rd 430.11.12.pdf
Uploaded by Christine Webb on Apr 22, 2021 at 8:06 am

pdf 06-15-21 CCSP-21-9 Spec Permit WSPOD.pdf
Uploaded by LINDA KOUTOULAS on May 6, 2021 at 2:57 pm

doc Beekeeper Request.doc
Uploaded by Robert Harb on May 24, 2021 at 1:25 pm

pdf 20210602_33-1499_CEIStormwaterPeerReview1.pdf
Uploaded by Robert Moore on Jun 11, 2021 at 12:48 pm

pdf Haverhill Solar AMENDED CC Special Permit Application Letter 2021.08.16.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:00 pm

pdf _Haverhill Solar AMENDED Site Plan Set 2021.08.16.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:26 pm

pdf Appendix1-AMENDED Solar Farm Components.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:05 pm

pdf Appendix2-AMENDED SWM Report and O&M.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:10 pm

pdf Appendix3-Solar Facility O&M.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:04 pm

pdf Appendix4-ConstructionAccessAgreement.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:04 pm

pdf Appendix5-AMENDED Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV One-Line Rev9-E-1).pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:04 pm

pdf Appendix6-Solar Site Illustratives.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:05 pm

PDF Appendix7-Whittier School Sewer Plan.PDF
Uploaded by Robert Harb on Aug 17, 2021 at 8:26 pm

pdf Appendix8-AMENDED Haverhill Fire Department Cart Path Proposal.pdf
Uploaded by Robert Harb on Aug 17, 2021 at 8:08 pm

doc Solar-2021.08.16 189 Amesbury Line Rd - Special Permit Comments and RESPONSES.docx
Uploaded by Robert Harb on Aug 17, 2021 at 8:05 pm

History

Date	Activity
Apr 15, 2021 at 7:15 pm	Robert Harb started a draft of Record CCSP-21-9
Apr 15, 2021 at 7:37 pm	Robert Harb added attachment _Haverhill Solar Site Plan Set 2021.04.08.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:42 pm	Robert Harb added attachment Appendix1-Solar Farm Components.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:43 pm	Robert Harb added attachment Appendix2-SWM Report and O&M.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:43 pm	Robert Harb added attachment Appendix3-Solar Facility O&M.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:44 pm	Robert Harb added attachment Appendix4-ConstructionAccessAgreement.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:44 pm	Robert Harb added attachment Appendix5-Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV Rev6-E-1).pdf to Record CCSP-21-9
Apr 15, 2021 at 7:45 pm	Robert Harb added attachment Appendix6-Solar Site Illustratives.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:45 pm	Robert Harb added attachment Appendix7-Whittier School Sewer Plan.PDF to Record CCSP-21-9
Apr 15, 2021 at 7:48 pm	Robert Harb added attachment solar control.pdf to Record CCSP-21-9
Apr 15, 2021 at 7:49 pm	Robert Harb added attachment solar description.pdf to Record CCSP-21-9
Apr 15, 2021 at 8:03 pm	Robert Harb submitted Record CCSP-21-9
Apr 15, 2021 at 8:12 pm	completed payment step Special Permit Filing Fee on Record CCSP-21-9
Apr 15, 2021 at 8:12 pm	approval step Building Inspector Review was assigned to Tom Bridgewater on Record CCSP-21-9
Apr 15, 2021 at 8:12 pm	approval step Planning Director Review was assigned to William Pillsbury on Record CCSP-21-9
Apr 15, 2021 at 8:12 pm	approval step City Clerk Review - Hearing Dates Set was assigned to Maria Bevilacqua on Record CCSP-21-9
Apr 16, 2021 at 11:07 am	William Pillsbury approved approval step Planning Director Review on Record CCSP-21-9
Apr 16, 2021 at 11:41 am	LINDA KOUTOULAS added attachment Zoning opinion to Record CCSP-21-9
Apr 16, 2021 at 11:41 am	LINDA KOUTOULAS removed attachment Zoning Opinion from Record CCSP-21-9
Apr 21, 2021 at 3:58 pm	LINDA KOUTOULAS changed IF OTHER, Please Describe from " Water Supply Protection District (WSPD) Special Permit" to " Water Supply Protection District Overlay (WSPOD) Special Permit" on Record CCSP-21-9

Date	Activity
Apr 21, 2021 at 3:58 pm	LINDA KOUTOULAS changed Thoroughly Describe the Reason(s) for thre Special Permit from "WATER SUPPLY PROTECTION DISTRICT (WSPD) SPECIAL PERMIT FOR INSTALLATION OF A LARGE SCALE GROUND M" to "WATER SUPPLY PROTECTION OVERLAY DISTRICT (WSPOD) SPECIAL PERMIT FOR INSTALLATION OF A LARGE SCALE" on Record CCSP-21-9
Apr 21, 2021 at 3:58 pm	LINDA KOUTOULAS changed Thoroughly Describe the Reason(s) for thre Special Permit from "WATER SUPPLY PROTECTION OVERLAY DISTRICT (WSPOD) SPECIAL PERMIT FOR INSTALLATION OF A LARGE SCALE" to "WATER SUPPLY PROTECTION OVERLAY DISTRICT (WSPOD) SPECIAL PERMIT FOR INSTALLATION OF A LARGE SCALE" on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step City Council Clerk Notified to LINDA KOUTOULAS on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step Assessor for Abutter's List to Christine Webb on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step Conservation Department Review to Robert Moore on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step DPW Review to John Pettis on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step Engineering Department Review to John Pettis on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step Fire1 Department Review to Robert O'Brien on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step Health Department Review to Bonnie Dufresne on Record CCSP-21-9
Apr 21, 2021 at 3:59 pm	LINDA KOUTOULAS assigned approval step Police Department Review to Robert Pistone on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step School Department Review to Margaret Marotta on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Storm Water Review to Robert Ward on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Wastewater Review to Robert Ward on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Water Department Review to Robert Ward on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Water Supply Review to Robert Ward on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Planning Director Approval for Agenda to William Pillsbury on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Building Inspector Approval for Agenda to Tom Bridgewater on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step First Ad Placement to LINDA KOUTOULAS on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Placed on Agenda to LINDA KOUTOULAS on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Abutter Notification to LINDA KOUTOULAS on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step Second Ad Placement to LINDA KOUTOULAS on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step City Councilor A Review to Melinda Barrett on Record CCSP-21-9
Apr 21, 2021 at 4:00 pm	LINDA KOUTOULAS assigned approval step City Councilor B Review to Colin LePage on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor C Review to Joe Bevilacqua on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor D Review to John Michitson on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor E Review to Thomas Sullivan on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor F Review to Tim Jordan on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor G Review to Michael McGonagle on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor H Review to Mary Ellen Daly O'Brien on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Councilor I Review to William Macek on Record CCSP-21-9
Apr 21, 2021 at 4:01 pm	LINDA KOUTOULAS assigned approval step City Council Meeting to LINDA KOUTOULAS on Record CCSP-21-9
Apr 22, 2021 at 8:05 am	Christine Webb added attachment Abutters 139 Amesbury Line Rd 430.11.12.csv to Record CCSP-21-9
Apr 22, 2021 at 8:06 am	Christine Webb added attachment Mailing Labels 139 Amesbury Line Rd 430.11.12.pdf to Record CCSP-21-9
May 6, 2021 at 2:57 pm	LINDA KOUTOULAS added attachment 06-15-21 CCSP-21-9 Spec Permit WSPOD.pdf to Record CCSP-21-9
May 12, 2021 at 10:54 am	Tom Bridgewater approved approval step Building Inspector Review on Record CCSP-21-9
May 18, 2021 at 8:13 am	LINDA KOUTOULAS assigned approval step City Clerk Review - Hearing Dates Set to LINDA KOUTOULAS on Record CCSP-21-9
May 18, 2021 at 8:13 am	LINDA KOUTOULAS approved approval step City Clerk Review - Hearing Dates Set on Record CCSP-21-9
May 18, 2021 at 8:13 am	LINDA KOUTOULAS approved approval step City Council Clerk Notified on Record CCSP-21-9
May 18, 2021 at 8:13 am	LINDA KOUTOULAS assigned approval step Assessor for Abutter's List to LINDA KOUTOULAS on Record CCSP-21-9
May 18, 2021 at 8:13 am	LINDA KOUTOULAS waived approval step Assessor for Abutter's List on Record CCSP-21-9
May 18, 2021 at 8:13 am	approval step Fire2 Department Review was assigned to Michael Picard on Record CCSP-21-9
May 18, 2021 at 8:30 am	Eric Tarpy assigned approval step Fire1 Department Review to Eric Tarpy on Record CCSP-21-9
May 18, 2021 at 8:36 am	Robert Pistone approved approval step Police Department Review on Record CCSP-21-9
May 18, 2021 at 8:37 am	Bonnie Dufresne assigned approval step Health Department Review to Mark Tolman on Record CCSP-21-9
May 18, 2021 at 4:27 pm	Michael Picard approved approval step Fire2 Department Review on Record CCSP-21-9
May 24, 2021 at 1:25 pm	Robert Harb added attachment Beekeeper Request.doc to Record CCSP-21-9
May 25, 2021 at 3:53 pm	Eric Tarpy approved approval step Fire1 Department Review on Record CCSP-21-9
May 27, 2021 at 9:42 am	Karen Buckley assigned approval step DPW Review to Karen Buckley on Record CCSP-21-9
May 27, 2021 at 9:42 am	Karen Buckley assigned approval step DPW Review to John Pettis on Record CCSP-21-9
May 27, 2021 at 9:44 am	Karen Buckley assigned approval step Water Supply Review to Paul Jessel on Record CCSP-21-9

Date	Activity
May 27, 2021 at 9:44 am	Karen Buckley assigned approval step Wastewater Review to Paul Jessel on Record CCSP-21-9
May 27, 2021 at 9:45 am	Karen Buckley assigned approval step Water Department Review to Glenn Smith on Record CCSP-21-9
May 27, 2021 at 9:45 am	Karen Buckley assigned approval step Water Supply Review to John D'Aoust on Record CCSP-21-9
May 27, 2021 at 10:29 am	Paul Jessel approved approval step Wastewater Review on Record CCSP-21-9
May 27, 2021 at 1:47 pm	John D'Aoust approved approval step Water Supply Review on Record CCSP-21-9
Jun 1, 2021 at 4:41 pm	Glenn Smith approved approval step Water Department Review on Record CCSP-21-9
Jun 8, 2021 at 8:48 am	LINDA KOUTOULAS assigned approval step School Department Review to Mike Pfifferling on Record CCSP-21-9
Jun 8, 2021 at 2:19 pm	Mark Tolman approved approval step Health Department Review on Record CCSP-21-9
Jun 9, 2021 at 11:59 am	Mike Pfifferling approved approval step School Department Review on Record CCSP-21-9
Jun 10, 2021 at 9:18 am	LINDA KOUTOULAS assigned approval step Storm Water Review to Robert Moore on Record CCSP-21-9
Jun 11, 2021 at 12:47 pm	Robert Moore approved approval step Conservation Department Review on Record CCSP-21-9
Jun 11, 2021 at 12:47 pm	Robert Moore approved approval step Storm Water Review on Record CCSP-21-9
Jun 11, 2021 at 12:48 pm	Robert Moore added attachment Stormwater Peer Review #1 to Record CCSP-21-9
Aug 12, 2021 at 9:48 am	LINDA KOUTOULAS assigned approval step DPW Review to Mike Stankovich on Record CCSP-21-9
Aug 17, 2021 at 8:00 pm	Robert Harb added attachment Haverhill Solar AMENDED CC Special Permit Application Letter 2021.08.16.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:01 pm	Robert Harb added attachment _Haverhill Solar AMENDED Site Plan Set 2021.08.16.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:02 pm	Robert Harb added attachment Appendix1-AMENDED Solar Farm Components.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:02 pm	Robert Harb added attachment Appendix2-AMENDED SWM Report and O&M.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:02 pm	Robert Harb added attachment Appendix3-Solar Facility O&M.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:03 pm	Robert Harb added attachment Appendix4-ConstructionAccessAgreement.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:03 pm	Robert Harb added attachment Appendix5-AMENDED Electrical One-Line Diagram (139 Amesbury Line Haverhill MA PV One-L to Record CCSP-21-9
Aug 17, 2021 at 8:03 pm	Robert Harb added attachment Appendix6-Solar Site Illustratives.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:04 pm	Robert Harb added attachment Appendix7-Whittier School Sewer Plan.PDF to Record CCSP-21-9
Aug 17, 2021 at 8:04 pm	Robert Harb added attachment Appendix8-AMENDED Haverhill Fire Department Cart Path Proposal.pdf to Record CCSP-21-9
Aug 17, 2021 at 8:05 pm	Robert Harb added attachment Solar-2021.08.16 189 Amesbury Line Rd - Special Permit Comments and RESPONSES.docx to Record CCSP-21-9

Timeline

Label	Status	Activated	Completed	Assignee	Due Date
Special Permit Filing Fee	Paid	Apr 15, 2021 at 8:03 pm	Apr 15, 2021 at 8:12 pm	-	-
✓ Planning Director Review	Complete	Apr 15, 2021 at 8:12 pm	Apr 16, 2021 at 11:07 am	William Pillsbury	-
✓ Building Inspector Review	Complete	Apr 15, 2021 at 8:12 pm	May 12, 2021 at 10:54 am	Tom Bridgewater	-
✓ City Clerk Review - Hearing Dates Set	Complete	Apr 15, 2021 at 8:12 pm	May 18, 2021 at 8:13 am	LINDA KOUTOULAS	-
✓ City Council Clerk Notified	Complete	May 18, 2021 at 8:13 am	May 18, 2021 at 8:13 am	LINDA KOUTOULAS	-
Assessor for Abutter's List	Skipped	May 18, 2021 at 8:13 am	May 18, 2021 at 8:13 am	LINDA KOUTOULAS	-
✓ Police Department Review	Complete	May 18, 2021 at 8:13 am	May 18, 2021 at 8:36 am	Robert Pistone	-
✓ Fire2 Department Review	Complete	May 18, 2021 at 8:13 am	May 18, 2021 at 4:27 pm	Michael Picard	-
✓ Fire1 Department Review	Complete	May 18, 2021 at 8:13 am	May 25, 2021 at 3:53 pm	Eric Tarpy	-
✓ Wastewater Review	Complete	May 18, 2021 at 8:13 am	May 27, 2021 at 10:29 am	Paul Jessel	-
✓ Water Supply Review	Complete	May 18, 2021 at 8:13 am	May 27, 2021 at 1:47 pm	John D'Aoust	-
✓ Water Department Review	Complete	May 18, 2021 at 8:13 am	Jun 1, 2021 at 4:41 pm	Glenn Smith	-
✓ Health Department Review	Complete	May 18, 2021 at 8:13 am	Jun 8, 2021 at 2:19 pm	Mark Tolman	-
✓ School Department Review	Complete	May 18, 2021 at 8:13 am	Jun 9, 2021 at 11:59 am	Mike Pfifferling	-
✓ Conservation Department Review	Complete	May 18, 2021 at 8:13 am	Jun 11, 2021 at 12:47 pm	Robert Moore	-

Label	Status	Activated	Completed	Assignee	Due Date
✔ Storm Water Review	Complete	May 18, 2021 at 8:13 am	Jun 11, 2021 at 12:47 pm	Robert Moore	-
✔ DPW Review	Active	May 18, 2021 at 8:13 am	-	Mike Stankovich	-
✔ Engineering Department Review	Active	May 18, 2021 at 8:13 am	-	John Pettis	-
✔ Planning Director Approval for Agenda	Pending	-	-	William Pillsbury	-
✔ Building Inspector Approval for Agenda	Pending	-	-	Tom Bridgewater	-
✔ First Ad Placement	Pending	-	-	LINDA KOUTOULAS	-
✔ Placed on Agenda	Pending	-	-	LINDA KOUTOULAS	-
✔ Abutter Notification	Pending	-	-	LINDA KOUTOULAS	-
✔ Second Ad Placement	Pending	-	-	LINDA KOUTOULAS	-
✔ City Councilor A Review	Pending	-	-	Melinda Barrett	-
✔ City Councilor B Review	Pending	-	-	Colin LePage	-
✔ City Councilor C Review	Pending	-	-	Joe Bevilacqua	-
✔ City Councilor D Review	Pending	-	-	John Michitson	-
✔ City Councilor E Review	Pending	-	-	Thomas Sullivan	-
✔ City Councilor F Review	Pending	-	-	Tim Jordan	-
✔ City Councilor G Review	Pending	-	-	Michael McGonagle	-
✔ City Councilor H Review	Pending	-	-	Mary Ellen Daly O'Brien	-
✔ City Councilor I Review	Pending	-	-	William Macek	-
✔ City Council Meeting	Pending	-	-	LINDA KOUTOULAS	-
✔ Meeting Minutes & Decision Filed w/City Clerk	Pending	-	-	-	-

ROBERT D. HARB
ATTORNEY AT LAW
17 WEST STREET
HAVERHILL, MASSACHUSETTS 01830

TEL: (978) 373-5611
FAX: (978) 373-7441
EMAIL: bobharb@aol.com

Of Counsel
Alfred J. Cirome

April 8, 2021

City of Haverhill
City Council
4 Summer Street, Haverhill, MA 01830

RE: 139 Amesbury Line Road:

Application For Solar Energy System Special Permit and Water Supply Protection District (WSPD) Special Permit

Dear City Council:

On behalf of the Applicant and Lessee, Solar Smart LLC, application is hereby made for a Special Permit for Large Scale Ground Mounted Solar Energy System in accordance with the City Zoning Ordinance (see Sections 7.8 and following).

Application is also made for a Special Permit for the installation of this solar energy system within the Water Supply Protection District in accordance with the City Zoning Ordinance (See Section 9.2.7).

Reference is hereby made to all the Plans and Specifications filed with this Application as well as the written testimony of Kyle Burchard, P.E. also filed with this Application and incorporated herein by reference

Financial Surety for this Large Scale Ground Mounted Solar Energy System project has been reviewed with the Planning Director and will be filed if this Special permit is approved during the Appeal period.

Applicant, based upon the testimony, plans and evidence submitted herewith and supplemented at the Public Hearing, respectfully requests the City Council to make a written determination and find that:

1. The proposed use or structure(s) shall not cause substantial detriment to the neighborhood or the City, taking into account the characteristics of the site and of the proposal in relation to that site.
2. The grant of a special permit for a large-scale ground-mounted solar energy system will promote the highest and best use of the subject property, taking into account the characteristics of the

subject property, including past land uses, possible presence of hazardous materials, and other development limitations.

3. There are Community energy needs which are served by this Project.
4. There is safe traffic and pedestrian flow provided by this Project.
5. There are adequate utilities and other public services for this Project.
6. The Natural Environment will not be impacted.
7. There is no impact on City services and this project will increase the city tax base.

In addition to meeting the above, the Council can also find that the proposed use:

1. Satisfies the design and operations guidelines set forth in the Zoning Ordinance;
2. Is in harmony with the purposes and intent of this Section and will promote the purposes of the WSPD;
3. Is appropriate to the natural topography, soils, and other characteristics of the site to be developed;
4. Will not, during construction or thereafter, have an adverse environmental impact on any water body or watercourse in the district; and 5. Will not adversely affect the quality or quantity of an existing water supply.

The Applicant respectfully requests Council approval of both the Solar Energy System Special Permit and The Water Supply Protection District (WSPD) Special Permit.

Respectfully submitted

Robert D. Harb Attorney for Solar Smart LLC

Robert D. Harb, Attorney for Solar Smart LLC

GPR

Civil Engineering • Land Planning • Land Surveying

Engineering Solutions for Land & Structures

April 8, 2021
AMENDED August 16, 2021

City of Haverhill
City Council
4 Summer Street, Haverhill, MA 01830

RE: 139 Amesbury Line Road Solar Farm
Application for Solar Energy Special Permit (§7.8.11) and
Application for Water Supply Protection District (WSPD) Special Permit (§9.2.7)

Dear City Council:

On behalf of Solar Smart, LLC, the Applicant and Lessee, Goldsmith, Prest & Ringwall, Inc. (GPR) has compiled information below to support two special permit requests for the proposed 2 MW AC solar farm project at 139 Amesbury Line Road, City of Haverhill Assessors Property ID#430-11-12.

These special permit applications, including the plans and accompanying text, meet all the requirements to allow full evaluation of the proposed Large-Scale Ground-Mounted Solar Energy Use (hereinafter called the "Solar Lease Area") within the RS & RM Zoning Districts and within the City of Haverhill Water Supply Protection District (WSPD).

Introduction

The total land area of the subject property measures 26.81± acres, of which the proposed Solar Lease Area measures ~~18.40±~~ 18.60± acres. Approximately 2,505 square feet of ~~J~~jurisdictional wetlands present on the property shall ~~not~~ be altered and mitigated by wetland replication areas.~~, and~~ ~~w~~Work within wetlands and wetland buffer zones ~~shall be~~ is documented in a Notice of Intent filing to the City of Haverhill Conservation Commission.

The Solar Lease Area partially straddles a natural drainage divide between the Merrimack River (to the east) and the Millvale Reservoir (to the west). This natural drainage divide also defines the limits of the City of Haverhill Water Supply Protection District (WSPD) for the Millvale Reservoir, as well as a zoning district line between the RS (Special Rural) and RM (Medium Density) residential zones. The WSPD and RS are one and the same over the Solar Lease Area. The WSPD also places a Zone 'A' Surface Water Supply Protection Area on the subject property, outside the Solar Lease Area. The remainder of the WSPD on the Solar Lease Area is considered Zone 'C' Surface Water Supply Protection Area, and all disturbances shall be documented in a Notice of Intent filing to the City of Haverhill Conservation Commission.

The solar energy facility is allowed in all districts by Special Permit, except the Waterfront District, as stipulated under *City Ordinance Section 7.8.3.1*. The project is not located in any portion of a Waterfront District.

Solar Energy Special Permit Request
City Ordinance Section 7.8.11 Special Permit Criteria for the Large-Scale Ground-Mounted Solar Energy Systems use states:

> *"In addition to any other criteria set forth in this Ordinance for the grant of a special permit, the SPGA shall consider whether the grant of a special permit for a Large-Scale Ground-Mounted Solar Energy System will promote the highest and best use of the subject property, taking into account the characteristics of the subject property, including past land uses, possible presence of hazardous materials, and other development limitations."*

The proposed Solar Lease Area is currently forested, and slopes varying from 5% - 20% towards the Whittier School Driveway. The land is known to have been farmed in the past, and an old cart path and stone wall cuts generally east to west through the middle of the property, providing rough vehicular access and a scenic walking trail that has been used for several years.

The current WSPD overlay is built upon state code provisions in 314 CMR 4.00 Massachusetts Surface Water Quality Standards and 310 CMR 22.00 Drinking Water, in which there are numerous limitations on the installation of septic systems, animal farming, and uses of herbicides and pesticides, in order to protect and promote surface water quality. Test holes for drainage were dug, spaced across the Solar Lease Area, that identified relatively consistently shallow seasonal high groundwater depths.

Development options for the property are somewhat limited by the forementioned regulatory, topographic and subsurface groundwater constraints. Possible development options could include moderate-intensity organic farming, and limited residential development. These options, as well as leaving the land undeveloped, could comply with regulations and conform to the constraints of the land.

The proposed solar energy farm represents a highest and best use of the land within the various regulatory and physical constraints. The solar energy farm consists of construction materials and methods that produce no hazardous or toxic wastes or byproducts. At this location, a cooperative educational relationship is in development with Paul Moskevitz, the Vocational Technical Director of the Whittier Regional Vocational Technical School. The plan is to supply the school with access to weather and solar output data, along with access to resources for emerging technologies in energy systems engineering. Raised observation areas are proposed, along with a perimeter trail to maintain the old cart path walking connection. In addition to a WSPD compliant design, pollinator seeding areas are proposed and bee hives are to be installed to promote future generations of fruitful habitat in the area.

In a broader sense, our modern society that has been built on electrical infrastructure fueled by the combustion of fossil fuels, coal and natural gas, is sourcing other fuels, including solar. Local solar energy sources provide local power grids and end users with better options from distributed power generation. Improved battery technology to be employed at 139 Amesbury Line Road will also help buffer periods of peak power usage to add resilience to the local power grid. Over time, solar installations will provide renewable, distributed, redundant, and clean energy sources serving local communities directly.

Harnessing solar energy is a highest and best use for the land at 139 Amesbury Line Road, today and into the future, with the installation of mature solar technology, accompanied by the other proposed elements for environment and education.

Water Supply Protection District (WSPD) Special Permit Request

City of Haverhill Ordinance Section 9.2 Water Supply Protection District (WSPD) lists in *Section 9.2.7 Uses Permitted by Special Permit,* nine (9) articles describing qualified use categories which may be granted special permit by the City Council. The proposed solar energy facility qualifies for special permit under the fourth article, (*Ordinance Section 9.2.7.4*) which states:

> *"Any use otherwise permitted as of right or by special permit that requires a permit under the National Pollutant Discharge Elimination System permit program established pursuant to 33 U.S.C § 1342, the Surface Water Discharge Permit Program established pursuant to M.G.L. c.21, s.43, or the Groundwater Discharge Permit Program established pursuant to M.G.L. c. 21, s.43."*

As the solar energy facility is allowed by special permit in all but the WD District (§7.8.11), and greater than 1 acre of proposed land disturbance triggers a National Point Discharge Elimination System (NPDES) with the U.S. Environmental Protection Agency (EPA) under a Construction General Permit Notice of Intent (CGP-NOI), *Ordinance Section 9.2.7.4* allows the City Council to grant a WSPD Special Permit. The following is complete in all regards, meeting all the requirements of the City of Haverhill Ordinance to allow full evaluation of the proposed use on the Water Supply Protection District. The information is provided in sequence according to the numbering listed in the City of Haverhill Ordinance.

§9.2.8.1. Application. This Application has a list of all state, local and federal permits, licenses and approvals required for the proposed activity, and the status of all such permits, licenses and approvals:

Permit	Status
Haverhill Solar Energy Special Permit	Applied
Haverhill WSPD Special Permit	Applied
Haverhill Conservation Commission NOI	~~Not Yet~~ Applied
EPA CGP-NOI	Apply for Construction
General Contractor License	Pending Selection
Building Permit	Apply for Construction
Electrical Permit	Apply for Construction

§9.2.8.2. This application is prepared in accordance with the data requirements and BMPs of the proposed development (e.g., including but not limited to erosion and sedimentation control plan, stormwater requirements, septic system designs).

An updated Stormwater Management Report, Long-Term Pollution Prevention Plan and Stormwater O&M Plan prepared in accordance with the Massachusetts Stormwater Management Handbook, and in response to Peer Review comments to the Notice of Intent application, describing all BMP's is provided as attachment to this application. A Solar Facility O&M Manual is also provided as attachment. A complete updated site plan set is provided as attachment, to depict geometric layouts, grading, drainage, and erosion and sedimentation control plans and details.

§9.2.8.3. This application is required to include a complete list of chemicals, pesticides, fuels and other potentially hazardous materials to be used or stored on the premises in any quantity, however, there are none proposed with this project. The application shall include a Management Plan for the handling, storage and disposal of any materials identified.

Lithium-ion batteries used for energy storage and power transfer are proposed in fire-rated enclosures, with non-toxic fire suppression systems. Detailed technical information on these systems are included as attachment. No chemicals, pesticides, fuels or other potentially hazardous materials are proposed to be used or stored on the premises.

Electric transformers contain fluids for cooling. The transformers used on this project shall use Envirotemp™ 360 or FR3 fluid, which have the same general chemical composition as vegetable oil.

The proposed battery enclosures have a triple redundancy protection against failures. The modes of protection consist of:

1. The connex box itself is a sealed steel enclosure affixed to a concrete pad. The batteries are located inside the steel enclosure, protected from weather exposure.
2. An integrated cooling system and thermostat keeps the batteries from overheating.
3. The enclosure is equipped with a "FM-200™ Clean Agent Fire Suppression System" using the cleanest fire suppression technology available. A material safety data sheet for the active chemical, HFC-227ea is included in the appendix.

Should the cooling system fail, and the fire extinguishing system fail, any combustion of materials inside the steel connex container remains inside the container.

§9.2.8.4. This application includes an analysis by a professional Massachusetts licensed engineer experienced in groundwater evaluation to demonstrate that the proposed activity will not be detrimental to the purposes of this district as set forth in Section 9.2.1.

The proposed activity is not detrimental to the watershed to be protected.
The proposed solar panels, electrical equipment pads and gravel driveway do not generate TSS or other pollutants. The proposed drainage system provides stormwater recharge and peak flow attenuation in accordance with the standards of the Massachusetts Stormwater Management Handbook.

The site is within the watershed of the Millvale Reservoir. The existing ground surface within the project area is generally at a 15% slope draining towards the Whittier School driveway to the north. Roadside ditches along the Whittier School driveway capture runoff from the hillside and convey runoff under the road via three (3) concrete pipe culverts to a large wetland complex north of the driveway.

Two wetland areas on the subject property were flagged by wetland scientist Matthew S. Marro in September and October 2020. The third, larger wetland area on the north side of the Whittier School driveway was also flagged at this time. In July 2020, the Haverhill Conservation Commission hired a delineation consultant, Mary Rimmer of Rimmer Environmental Consulting, LTD who made changes and additions to the wetland delineation by Matthew Marro. The two consultants met and conferred on the delineation as shown on the Plan Amended 8/16/21, changing the shape of the two wetland areas and adding a third, isolated wetland area subject to the City of Haverhill Wetland Bylaw. Following the updated delineation, the project proposes wetland replication as mitigation for wetland impacts. The two primary wetland areas on the subject property form broad swales for conveyance of surface waters, and being at low points in the grade, these swales generally discharge into the drainage culverts under the Whittier School driveway. Some of the new delineated wetlands areas being impacted do not flow toward the Whittier driveway and are not in the WSPD.

On 1/8/2021 soil investigation of the property was conducted by Kyle Burchard, P.E., registered Massachusetts Soil Evaluator #14048. A series of drainage test pits were dug in several locations across the proposed development in order to identify estimated seasonal high groundwater elevations and existing soil conditions. Test hole logs are included in the Stormwater Management Report attached to this application. The seasonal high water table was identified fairly consistently at 27" below the ground surface according to mottles in the soil. The chroma in the strata below the estimated seasonal high groundwater was not significantly gleyed, indicating that the soils were typically saturated without a large amount of seasonal variation in the groundwater elevation that would tend to wash more of the chroma away. The soil profile and characteristics were consistent across the whole project area, being relatively shallow groundwater and a composition of sandy loam and loam.

The relatively shallow groundwater condition on the site, and the indication of nearly constant saturation supports the proposed site stormwater BMP strategy of minimal surface grading and no impervious pavement. Long, shallow-depth, and minimally-sloped grassed swales with check dams will be incised along the hillside to capture, slow, and promote runoff recharge to groundwater. The proposed shallow manipulation of surface soils achieves the minimum Massachusetts Stormwater Management Handbook Standards of matching pre-development to post-development peak flows, maintaining existing groundwater recharge, and promoting water quality.

The drainage calculations for the grassed swales, conveyance channels and detention basins in the Stormwater Management Report show appropriate compensation for the change in land cover from forested to grassed hillside and gravel driveway conditions.

The Massachusetts Stormwater Handbook targets a neutral stormwater impact with various BMP's and the assortment of measures proposed achieve that.

§9.2.9. Design and Performance Standards.

At the time of this application, the proposed Solar Lease Area area is wooded with a gravel cart path crossing through it from east to west, bounded on the south side by a stone wall. Other various stone walls mark some of the boundaries of the subject property. Two wetland fingers reach into the property from culverts under the adjacent Whittier School driveway to the north. The only known former use of the property was as farmland. There are no known septic fields, and no known hazardous materials on the property.

Access from Amesbury Line Road provides both temporary construction access, and permanent facility access for routine maintenance of the solar facility. This driveway access provides Fire and EMS access as well. The gravel access driveway will also be maintained as needed for stable passage. The first 280 feet of driveway from Amesbury Line Road will be treated in an alternative manner so as to appear like an old cart path, but with a stable construction meeting the approval of the Haverhill Fire Department. During construction a secondary construction access has been secured by agreement with the abutting property owner of 235 Amesbury Line Road. This secondary access will reduce construction traffic passage on the primary access driveway.

§9.2.9.1 Safeguards.

Three (3) pad-mounted and enclosed lithium-ion battery banks are proposed with the project. These three (3) large batteries are equipped with automatically deployed gaseous fire-suppression systems that suffocate any fire instantaneously without toxic residues.

Supports for the proposed solar panels consist of driven stainless-steel posts.

Buried wires and cabling are all waterproofed and insulated.

No toxic or hazardous materials or byproducts result from the solar farm installation.

§9.2.9.2. Location.
The WSPD boundary onsite has been delineated by the natural drainage divide. Small deviations in the post-development drainage conditions are delineated on the drainage divide maps included with the Stormwater Management Report.
No toxic or hazardous discharges, nor septic discharges are proposed within the WSPD, or on the site.

§9.2.9.3. Disposal.
No onsite subsurface sewage disposal systems are proposed with this project.

§9.2.9.4. Stormwater.
The design of stormwater management measures conforms to the Massachusetts Stormwater Standards in all regards. See the Stormwater Management Report attached to this application.

The Applicant, based upon the testimony, plans and evidence submitted herewith and supplemented at the Public Hearing, respectfully requests that the City Council make a written determination and find that:

1. The proposed use or structure(s) shall not cause substantial detriment to the neighborhood or the City, taking into account the characteristics of the site and of the proposal in relation to that site.
2. There are Community energy needs which are served by this Project.
3. There is safe traffic and pedestrian flow provided by this Project.
4. There are adequate utilities and other public services for this Project.
5. The Natural Environment will not be impacted.
6. There is no impact on City services and this project will increase the city tax base.

In addition to meeting the above criteria set by Section 10.4.2, the Council can also find that the proposed use:

1. Satisfies the design and operations guidelines set forth in the Zoning Ordinance;
2. Is in harmony with the purposes and intent of this Section and will promote the purposes of the WSPD;
3. Is appropriate to the natural topography, soils, and other characteristics of the site to be developed;
4. Will not, during construction or thereafter, have an adverse environmental impact on any water body or watercourse in the district; and
5. Will not adversely affect the quality or quantity of an existing water supply.

The Applicant respectfully requests City Council approval of both the Solar Energy Special Permit and the Water Supply Protection District (WSPD) Special Permit.

Respectfully submitted,

Kyle Burchard, P.E.

Application Attachments:

Haverhill Solar Site Plan Set
Appendix 1- Solar Farm Components
Appendix 2- Stormwater Management Report and Operations & Maintenance Plan
Appendix 3- Solar Facility Operations & Maintenance Plan
Appendix 4- Construction Access Agreement
Appendix 5- Electrical One-Line Diagram
Appendix 6- Solar Site Illustratives
Appendix 7- Whittier School Sewer Plan

Copy to: Theodore Xenakis, Esq.
Solar Smart Development
Robert D. Harb, Esq.
GPR file 181084

Stormwater Management Report

Haverhill Solar Project
139 Amesbury Line Road
Haverhill, MA

April 2021
Revised August 2021

Submitted to:
City of Haverhill Department of Public Works
City of Haverhill Conservation Commission
4 Summer Street
Haverhill, MA 01830

Submitted by:
Solar Smart, LLC
1207 Congressional BLVD
Summerville, SC 29483

Prepared by:
Goldsmith, Prest & Ringwall, Inc.
39 Main Street, Suite 301
Ayer, MA 01432

COMMONWEALTH OF MASSACHUSETTS
KYLE
BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED
PROFESSIONAL ENGINEER

8/16/21

Project No:
181084

GPR Engineering Solutions for Land & Structures

Table of Contents

Section 1

Introduction and Methodology

Introduction and Methodology

Regulatory Requirements and Design Intent

This narrative is intended to accompany the stormwater management report for the large scale ground mounted solar energy system known as the Haverhill Solar Project. Included in this report are calculations that support engineering design as required by the MassDEP Stormwater Management Handbook and applicable City of Haverhill Rules and Regulations. Site specific information is presented under two scenarios, "pre-development" and "post-development" conditions, so that potential impacts due to the project can be identified, quantified and, as necessary, mitigated.

The final design intent seeks to meet the following interrelated goals:

1. Limit stormwater runoff rates for the 2, 10, and 100-year storms to existing (predevelopment) levels;

2. Provide adequate drainage for new surfaces;

3. Provide a cost-effective engineering solution that addresses regulatory as well as real-world constraints.

Existing Site Description

The subject property is shown on City of Haverhill Assessors Map 430, Block 11, Lot 12, and measures 26.81± acres. The property is generally bounded to the west by a private paved driveway serving the Whittier Regional Vocational Technical High School, to the north by Amesbury Line Road and residential properties, to the east by residential or farmed properties, and to the south by land holdings of the Whittier Regional Vocational Technical High School.

The subject site area is wholly contained within the subject property, and measures 18.40± acres. The subject site is referred to herein as the "Solar Lease Area" for the proposed installation of a Large-Scale Ground-Mounted Solar Energy System.

The Solar Lease Area partially straddles a natural drainage divide between the Merrimack River to the east, and the Millvale Reservoir to the west. This natural drainage divide also defines the limits of the City of Haverhill Water Supply Protection District (WSPD) for the Millvale Reservoir, as well as a zoning district line between the RS (Special Rural) and RM (Medium Density) residential zones. The WSPD and RS are one and the same over the Solar Lease Area. The WSPD also contains a Zone 'A' Surface Water Supply Protection Area on the subject property under definitions for public water supplies listed in 310 CMR 22.02 and is a Critical Area being addressed under the Massachusetts Stormwater Standard #6 herein. The Zone 'A' is outside the Solar Lease Area, and the remainder of the WSPD on the Solar Lease Area is defined as Zone 'C' Surface Water Supply Protection Area.

The subject property contains two (2) bordering vegetated wetland (BVW) areas, the westerly BVW being a long, finger-like wetland area projecting into the Solar Lease Area. After additional testing, the easterly BVW was determined to extend through the limits of the Solar Lease Area, within an area of proposed work, requiring minor alterations to the BVW. These two BVW areas occupy approximately 43,345 square feet on the overall subject property.

The subject property is mostly wooded with an existing single-family residence and driveway to the north, plus a separate gravel cart path trail crossing generally west-southwest to east-northeast through the property, along with several portions of stone walls. The existing house sits atop a rise in the landform with slopes as steep as 3:1 towards Amesbury Line Road, towards the Whittier School Driveway and to the easterly BVW. The Solar Lease Area that is covered by the WSPD generally drains westward towards the Whittier School driveway with relatively consistent land slopes between 10% and 20%. The Solar Lease Area outside the WSPD drains generally eastward with slopes between 1% and 8%. Relative high points in the topography at the western boundary of the Solar Lease Area also drain directly towards adjacent land owned by the Whittier School (Analysis Point #3 (AP-3)).

Analysis Point #1 (AP-1) is outside the WSPD, draining generally southeastward, ultimately towards the Merrimack River, a drainage area measuring 4.04± acres, consisting of both onsite areas and offsite areas passing through proposed BMP controls. The point of analysis is taken at the subject property line in common with the abutting property of Map 430 Block 11 Lot 12.

Analysis Point #2A (AP-2A) is entirely within the WSPD, and drains westward, ultimately towards the Millvale Reservoir, a drainage area measuring 16.63± acres, consisting of both onsite areas and offsite areas bypassing proposed BMP controls. The point of analysis is taken at one of the upstream headwalls/culverts for the Whittier School driveway, a 36" Reinforced Concrete Pipe (RCP).

Analysis Point #2B (AP-2B) is entirely within the WSPD, and drains westward, ultimately towards the Millvale Reservoir, a drainage area measuring 8.69± acres, consisting of both onsite areas and offsite areas bypassing proposed BMP controls. The point of analysis is taken at one of the upstream headwalls/culverts for the Whittier School driveway, a 24" Reinforced Concrete Pipe (RCP).

Analysis Point #3 (AP-3) is entirely within the WSPD, and drains south-southwesterly towards abutting lands owned by the Whittier School. The total drainage area measures 0.45± acres, not draining directly towards the Whittier School driveway.

Soil mapping from the Natural Resources Conservation Service (NRCS) indicates a small variety of soils generally confirmed by onsite soil testing. The NRCS lists Paxton Fine Sandy Loam, very stony on slopes varying from 8% to 35%, hydraulic soil group C, across the majority of the proposed Solar Lease Area and subject parcel. Deerfield

Loamy Fine Sand on 0% to 3% slopes, hydraulic group A is located in the northeast corner of the site along the driveway connection to Amesbury Line Road.

Site specific soil investigation consisted of a series of deep hole test pits, for drainage only, conducted on January 8, 2021 by a Certified Massachusetts Soil Evaluator. Soil logs of this investigation are included in the Appendix of this report, indicating fine sandy loam to loam soils and a typical seasonal high groundwater depth of 27-inches, corresponding to a hydrologic soil group C.

Project Description

The proposed project is to construct a 2± megawatt (MW) solar photovoltaic (PV) farm defined by the City of Haverhill Zoning Ordinance as a Large-Scale Ground-Mounted Solar Energy System consisting of 6,048 PV solar panels, supporting racking systems, chain link perimeter fencing and gates, with appurtenant wiring, conduits, inverters, transformers, battery storage units, secondary interconnection poles, buried and overhead electrical lines.

The proposed project also includes a gravel driveway for maintenance and emergency access with protective guardrail where appropriate, and numerous stormwater detention and conveyance BMP's as well as erosion and sediment control measures detailed on the Site Plan drawing set. Amenities also proposed include a restored trail connection across the property that is outside the fence line, educational observation platforms and kiosks, an apiary, several special seeding areas, and supplemental tree planting.

The proposed work includes all required electrical connections & equipment, wiring connections between the panels and inverters and transformer(s), some of which may be underground, and the interconnection of the entire array to the electrical grid via the existing pole and overhead power lines on Amesbury Line Road.

The solar panels will be installed above ground, and precipitation that lands on the panels will have the same opportunity to flow across permeable land to infiltrate in approximately the same distribution as it would in a pre-developed condition, by a series of distributed best management practices (BMP's) that clean and manage the runoff. The inherent increase of surface runoff due to changes in land cover is mitigated by the combination of BMP's that include a sediment forebay, grassed swales, conveyance channels, stone overflows, stone check dams, stone diaphragms, catch basins, outlet control structures and level spreader outlets.

Tree clearing is required to install the solar equipment, access driveway and BMP's, as well as to prevent shading of the panels. Total tree clearing on the subject site measures 14.6± acres, of which 13.7± acres will require removal of stumps, and 0.9±

acres within select BVW buffers will not be stumped or grubbed, as shown on the Site Plan drawing set. A total of 736 trees with 10" trunk diameter at breast height (DBH) or greater will be cut and of those, 693 stumps will be removed.

In the areas being stumped within the proposed solar panel arrays, topsoil stripping and surficial grading by raking or other mechanical processes will be performed to generally smooth the surface in preparation for the installation of numerous shallow (24"± deep) and flat (<0.5% longitudinal slope) grassed swales that shall provide the initial capture and detention storage of surface runoff.

When filled, the grass swales discharge over stone overflows into conveyance channels in which stone check dams will control flow velocities, sedimentation, and provide additional opportunities for groundwater recharge. The grass swales discharge to conveyance channels that discharge into two dry water quality swales (WQS's) with outlet control structures that allow for periodic inundation of the swales during higher rainfall events, affording an additional measure of stormwater detention. On the westerly side of the site, the grass swales and conveyance channels discharge to WQS #2 and on the easterly side of the site, the grass swales and conveyance channels discharge to WQS #1. A conveyance channel does discharge to WQS #3, however, no grass swales discharge to that particular conveyance channel. Additionally, each of these dry WQS's maintains a 2 foot separation between estimated high groundwater. Each WQS outlet control structure discharges concentrated flows through devices that mitigate flow energy and provide sheet flowing discharges. Each WQS also has a stone armored overflow spillway.

WQS's #1, #2 & #3 are located within the WSPD to manage WSPD critical area discharges. WQS #4 is outside the WSPD to manage non-WSPD discharges. WQS #4 primarily receives surface runoff from portions of the proposed gravel driveway. Unlike WQS's #1, #2 & #3, WQS #4 is proposed as a Wet Water Quality Swale and will be constructed at a minimum of 6" above the groundwater elevation.

WQS #4 has an outlet control structure discharging to a 12" perforated pipe within a 24" deep stone diaphragm, flush to grade, along the edge of a level portion of the driveway connection to Amesbury Line Road. This stone diaphragm provides another opportunity for recharge before activating surface discharge. WQS #4 also has a stone overflow towards the driveway, activated during the 100-year storm.

Steep topography along portions of the proposed driveway, and practical driveway slope limitations for emergency vehicles, result in cuts into existing grade greater than 27-inches that may seasonally intercept groundwater alongside portions of the driveway drainage ditches. Separate collection systems are proposed to convey and discharge such collected surface and/or groundwater flows at stable, riprap-armored, level spreader discharges to the easterly BVW.

All of the proposed grass swales, conveyance swales and Water Quality Swales are graded such that they do not intercept the estimated seasonal high groundwater. None of the BMP's are lined or otherwise prohibit exfiltration for groundwater recharge, but no retention of volume for exfiltration is calculated. This provides a conservative calculation of managing stormwater peak flow discharges through the stormwater system.

No generators of total suspended solids (TSS) are proposed, and the only proposed impervious areas consist of 1,916± square feet of solar equipment pads and observation decks. A 1" water quality volume (WQV) over the impervious areas yields a total WQV= 160± cubic feet. Runoff from these few equipment pads is directed through a single sediment forebay in combination with a grassed swale to yield 50% TSS, then through WQS #1 to achieve 85% TSS removal prior to discharging to the critical area, Zone 'A' Surface Water Supply Area.

The WQV required is 160± cubic feet and the WQV provided in WQS#1 is 425± cubic feet. The total recharge volume required is 129± cubic feet, and the sum total of WQV provided in the proposed Water Quality Swales is 630± cubic feet.

In general, grading will result in smoothing of existing contours without significant cut to fill earthwork, or significant soil/gravel material haul-off or haul-in. The existing stone walls will not be sufficient for the driveway and various erosion control stone armoring, and other onsite sources of crushed stone are not anticipated such that crushed stone will need to be hauled onto the site.

Soil/slope stabilization will be accomplished by a variety of loam and seed, stone armoring, some slope stabilization treatments and use of geotextile fabrics as noted and detailed on the Site Plan drawing set.

<u>Hydrologic and Hydraulic Computation Methodology</u>

Runoff rates and volumes were computed using the Soil Conservation Service TR-55 Method entitled "Urban Hydrology for Small Watersheds". The following 24-hour rainfall events were analyzed:

Frequency (years): 2, 10, and 100

Northeast Regional Climate Center (NRCC) rainfall depths for each rainfall event were used for hydrologic and hydraulic analyses within Hydro-CAD version 10.10-4a.

The four analysis points described above (AP-1, AP-2A, AP-2B and AP-3) have been used to evaluate both pre-developed and post-developed peak discharge rates for the design storm frequencies. The hydraulic and hydrologic model accounted for proposed changes to land cover via tree removal, pad-mounted equipment, gravel driveway construction, time of concentration via grading changes, and the proposed stormwater BMP improvements.

Additional nodes were added to the post-development model to account for the driveway, grassed swales, conveyance channels, water quality swales, and storm drainage piping, as depicted on the Watershed Maps and Diagrams provided herein.

Summary of Results

Surface Water Runoff

Tributary areas and peak rates of runoff for both conditions analyzed are displayed in the HYDROLOGY SUMMARY FOR 24-HOUR STORM that follows.

Compliance with Stormwater Management Standards

This project proposes nominal installation of impervious surfaces and an excess of water quality treatment measures in order to provide sufficient detention. This report seeks to show calculation of adequate treatment and peak runoff controls to demonstrate no proposed degradation to the existing wetland areas, critical areas or residential properties adjacent to the site. The following summary describes applicability of each Stormwater Standard, and compliance where required with the ten stormwater management standards as set forth on MassDEP "Checklist for Stormwater Report":

Standard 1: No New Untreated Discharges
The site proposes a sediment forebay in combination with a grassed swale and dry water quality swale to treat the limited new impervious equipment pads. The full treatment train path from these impervious equipment pads is; sediment forebay-grassed swale-stone overflow-conveyance swale-check dam-dry water quality swale-level spreader outlet.

Standard 2: Peak Rate Attenuation
Stormwater BMP's in the form of grassed swales, stone overflows, conveyance channels, check dams and dry water quality swales provide detention to attenuate peak rate discharges. At each analysis point, post-development peak rates of runoff are the same or less than pre-development for all storms analyzed.

Standard 3: Recharge
All panels are elevated on support frames above permeable ground. Each support frame has several support posts driven directly into the ground without excavation for footings. Each row of solar panels is also separated from adjacent rows and each panel within the row is separated from adjacent panels resulting in a varied flow distribution of the panel runoff, not simply at the lowest edge of the panel row. Grassed swales are skewed to the alignment of the panel rows providing additional varied distribution of the runoff. Rainfall hitting the panels will be able to splash and flow off onto the ground where the runoff is then afforded multiple pervious vegetated catchments to infiltrate and recharge to groundwater.

Standard 4: Water Quality

Water quality retention (first flush = 1.0") is required for the proposed 1,916± square feet of proposed impervious equipment pads & observation decks. Total Suspended Solid (TSS) treatment is provided via a sediment forebay and grassed swale combination that then flows through a water quality swale to achieve the minimum 80% TSS required for discharge into a critical area.

Standard 5: Land Uses With Higher Pollutant Loads

Not applicable.

Standard 6: Critical Area Discharges

Areas of the project site, including various outlets, discharge to a Zone 'A' Surface Water Supply Protection Area, and this is done to maintain existing flow patterns. The distributed points of discharge are at the end of a series of pervious detention and conveyance measures with multiple check dams and stone overflows acting as filters and energy dissipators. The points of discharge themselves are structural, armored level spreaders that re-establish sheet flow with energy dissipation at the outlet.

Standard 7: Redevelopments and Other Projects Applicable to the Standards Only to The Maximum Extent Practicable

This project is not a redevelopment project, and meets all applicable Standards as described hereon.

Standard 8: Construction Period Pollution Prevention and Erosion & Sediment Control

Measures for protecting the resource areas from construction period erosion and sediment are shown on the Permit Plans included with this report. The project shall be covered by a NPDES Construction General Permit but no SWPPP has been submitted. A SWPPP will be submitted as part of the NPDES Construction General Permit filing, no less than two weeks before land disturbance begins.

Standard 9: Operation & Maintenance Plan

An Operation and Maintenance Plan is attached.

Standard 10: Prohibition of Illicit Discharges

No Illicit Discharge Compliance Statement is attached but will be submitted prior to the discharge of any stormwater to post-construction BMPs.

Conclusion

The proposed BMP's provide adequate and appropriate stormwater detention and retention to compensate for the project's change in land cover from woods/brush to grass and gravel, and to mitigate the development's effects on runoff.

Further, the hydrologic drainage analysis of the project at three (3) analysis points show that peak runoff discharges from the project will be equal to or less than that which is discharged in the existing condition. Water quality treatment is provided as required, and appropriate mitigation for critical area discharges is provided. The project presents no degradation to the resource areas or abutting properties, and meets the applicable standards set forth in the MassDEP Stormwater Management Handbook, as detailed herein.

Section 2

Hydrology Summary for 24-hour Storm

HYDROLOGY SUMMARY FOR 24-HOUR STORM

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

PEAK DISCHARGE RATE

Pre-Development (cfs)

Analysis Point	2-YR	10-YR	100-YR
AP-1	1.6	4.3	12.2
AP-2A	6.2	16.3	45.8
AP-2B	5.3	13.5	37.5
AP-3	0.3	0.7	2.1

Development (cfs)

Analysis Point	2-YR	10-YR	100-YR
AP-1	1.6	4.2	12.2
AP-2A	6.0	15.8	45.7
AP-2B	5.2	12.5	32.9
AP-3	0.3	0.7	2.0

Pre-Development vs. Developed (cfs)

Analysis Point	2-YR	10-YR	100-YR
AP-1	**0.0**	**-0.1**	**0.0**
AP-2A	**-0.2**	**-0.5**	**-0.1**
AP-2B	**-0.1**	**-1.0**	**-4.6**
AP-3	**0.0**	**0.0**	**-0.1**

PEAK DISCHARGE VOLUME

Pre-Development (Cubic feet)

Analysis Point	2-YR	10-YR	100-YR
AP-1	9,688	23,168	64,033
AP-2A	35,778	85,567	236,495
AP-2B	42,086	98,686	268,207
AP-3	1,414	3,381	9,344

Development (Cubic feet)

Analysis Point	2-YR	10-YR	100-YR
AP-1	12,127	26,704	68,803
AP-2A	39,261	94,660	319,974
AP-2B	28,490	64,353	169,316
AP-3	1,401	3,284	8,925

Pre-Development vs. Developed (Cubic feet)

Analysis Point	2-YR	10-YR	100-YR
AP-1	**2,439**	**3,536**	**4,770**
AP-2A	**3,483**	**9,093**	**83,479**
AP-2B	**-13,596**	**-34,333**	**-98,891**
AP-3	**-13**	**-97**	**-419**

Section 3

Mass DEP Stormwater Management Report Checklist

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
KYLE BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED PROFESSIONAL ENGINEER

8/16/21

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☒ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☒ Water Quality Swale
- ☒ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Stone Diaphragm retention/recharge

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☒ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

☐ is within the Zone II or Interim Wellhead Protection Area

☒ is near or to other critical areas

☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☒ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

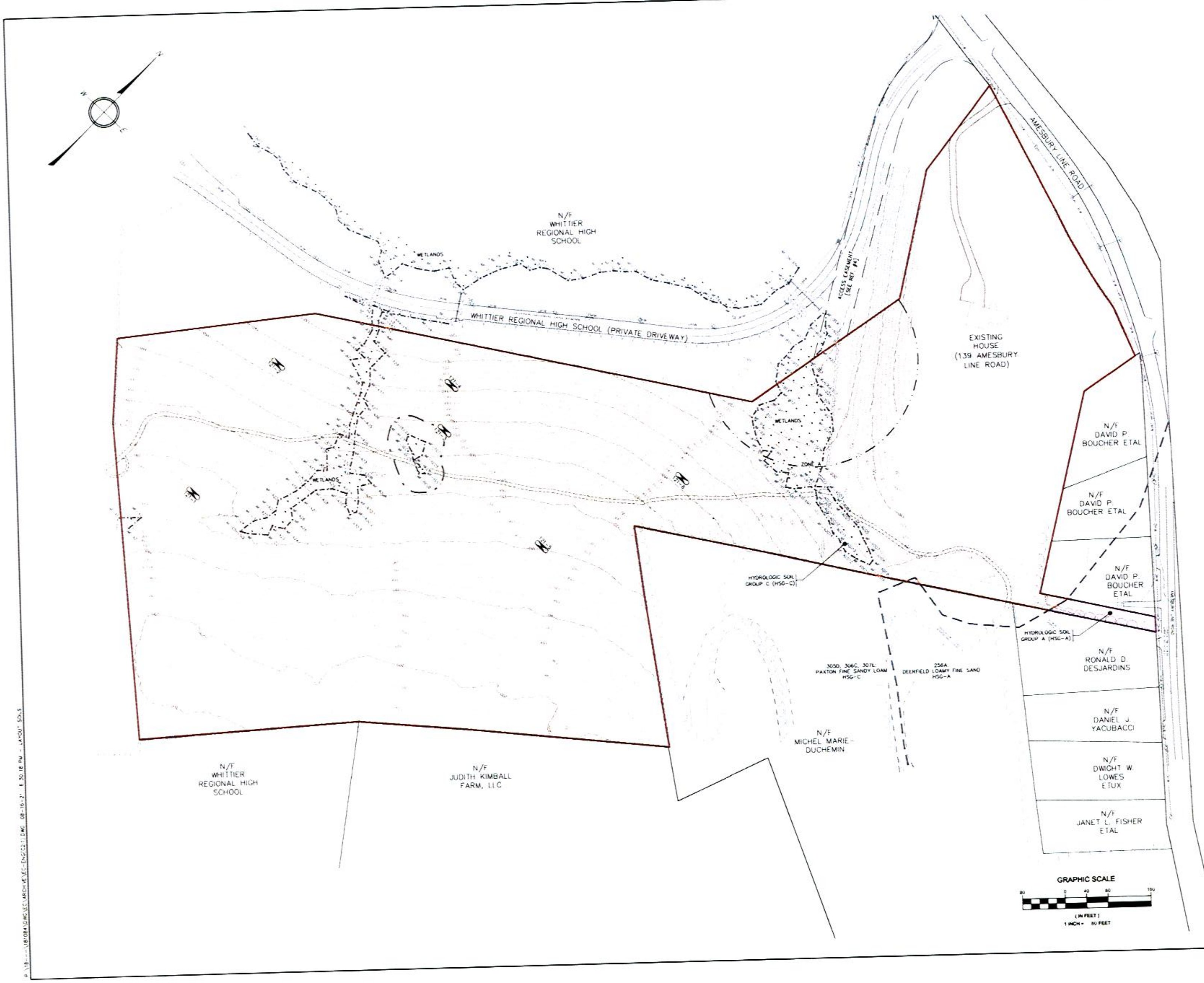
☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

Section 4

Appendix



LEGEND

EXISTING

- ELEVATION CONTOUR
- SPOT GRADE
- PROPERTY LINE
- WETLAND DELINEATION
- EDGE OF PAVEMENT
- GRAVEL/DIRT TRAIL
- CAPE COD BERM CURBING
- STONE WALL
- WATER VALVE
- FIRE HYDRANT
- GRAVITY SEWER LINE
- SEWER MANHOLE
- OVERHEAD POWER LINE
- UTILITY POLE
- STORM DRAIN
- DRAIN MANHOLE
- DEEP SOIL OBSERVATION HOLE
- ELEVATION BENCHMARK
- EDGE OF TREELINE

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION

■ PERMIT ☐ CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION

NO.	DATE	BY	APP	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS & ADDED WETLAND AREAS

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DES. BY: JFB CHK. BY: KFB | DATE: APRIL 2021 | JOB 181084 | 1 OF 3

Map Scale: 1:8,360 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 16, Jun 9, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 28, 2019—Sep 20, 2019

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	0.1	0.0%
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	1.8	0.5%
51A	Swansea muck, 0 to 1 percent slopes	3.2	0.9%
52A	Freetown muck, 0 to 1 percent slopes	44.7	12.9%
70A	Ridgebury fine sandy loam, 0 to 3 percent slopes	2.0	0.6%
253A	Hinckley loamy sand, 0 to 3 percent slopes	3.0	0.9%
253B	Hinckley loamy sand, 3 to 8 percent slopes	3.5	1.0%
253C	Hinckley loamy sand, 8 to 15 percent slopes	9.4	2.7%
255A	Windsor loamy sand, 0 to 3 percent slopes	5.4	1.6%
255B	Windsor loamy sand, 3 to 8 percent slopes	34.6	10.0%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	41.9	12.1%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	11.0	3.2%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	13.7	4.0%
305D	Paxton fine sandy loam, 15 to 25 percent slopes	40.8	11.8%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	16.7	4.8%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	21.6	6.2%
306D	Paxton fine sandy loam, 15 to 25 percent slopes, very stony	10.7	3.1%
307E	Paxton fine sandy loam, 25 to 35 percent slopes, extremely stony	35.0	10.1%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	9.9	2.9%
310C	Woodbridge fine sandy loam, 8 to 15 percent slopes	6.5	1.9%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	14.5	4.2%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
405B	Charlton fine sandy loam, 3 to 8 percent slopes	5.0	1.4%
600	Pits, gravel	11.1	3.2%
651	Udorthents, smoothed	0.0	0.0%
711C	Charlton-Rock outcrop-Hollis complex, 8 to 15 percent slopes	0.5	0.2%
Totals for Area of Interest		**346.5**	**100.0%**

FORM 11 - SOIL EVALUATOR FORM

No. 181084 Date: 1 8 21

Commonwealth of Massachusetts
Haverhill Massachusetts

Soil Suitability Assessment for On-Site Solar Project

Performed by: Kyle Burchard, PE, GPR Date: 3/17/21
Witnessed by:

Location Address: or Lot No.	Applicant's Nam / Address / Telephone No.
139 Amesbury Line Road Haverhill, MA (235 Amesbury Line Road - Access)	Applicant's Nam Solar Smart, LLC Address: 1270 Congressional BLVD Summerville, SC 29483 Telephone No.

New Construction ☑ Upgrade ☐ Repair ☐

Office Review

Published Soil Survey Available: No ☐ Yes ☑

Year Published Internet Publication Scale na Soil Map Unit 305D/306C
Soil Name Paxton Fine Sandy Loam Soil Limitations Depth to restrictive features, well drained
Soil Name - Soil Limitations -
Soil Name - Soil Limitations -

Surficial Geologic Report Available: No ☑ Yes ☐

Year Published MASS GIS Publication Scale
Geologic Material(Map Unit) Ice Contact Outwash
Landform Kame Terrace

Flood Insurance Rate Map: 25009C0092F

Above 500 Year Flood Boundary No ☐ Yes ☑
Within 500 Year Flood Boundary No ☑ Yes ☐
Within 100 Year Flood Boundary No ☑ Yes ☐
Within Velocity Zone No ☑ Yes ☐

Wetland Area:

National Wetlands Inventory Map (map unit) N/A
Wetlands Conservancy Program Map (map unit) N/A

Current Water Resource Conditions (USGS): Month March

Range: Above Normal ☐ Normal ☑ Below Normal ☐
Other Reference Reviewed USGS

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 139 Amesbury Line Road
Haverhill, MA
(235 Amesbury Line Road - Access)

On-Site Review

Deep Hole #: 121-1 Date: 01/08/21 Time: 9:30 AM Weather: Clear 30°
Location (identify on site plan) See Attached Sketch
Land Use Wooded Slope (%) 2%-4% Surfaces Stones Some Stones
(eg woodland, agricultural field, vacant lot etc...)
Vegatation Mixed Forest, Mostly Deciduous Upland
Landform Kame Terrace
Position on landscape See attached Sketch
Distances from:

Open Water Body >100 feet Drainage Way 100± feet
Possible Wet Area >100 feet Property Line 100± feet
Drinking Water Well >100 feet Other: feet

Deep Observation Hole Log

Hole # 121-1 NB Suface El. 181.9

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-11	A	sl	10YR 3/3	-	mvfr
11-28	B	sl	10YR 3/4	-	mvfr, most roots stop, 5% cobbles
28-96	C	sl	2.5YR 4/3	@ 28" 15% fm 7.5YR 6/6	mvfr 10% stones

Parent Material (geologic) Ice Contact Outwash Depth to Bedrock: >96"
Depth to Groundwater: Standing Water in the Hole n/a Weeping from Pit Face: 64"
Estimated Seasonal High Groundwater in the Hole 28"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 139 Amesbury Line Road
Haverhill, MA
(235 Amesbury Line Road - Access)

On-Site Review

Deep Hole #: 121-2 Date: 01/08/21 Time: 11:00 AM Weather: Clear 32°
Location (identify on site plan) See Attached Sketch
Land Use Wooded Slope (%) 2%-4% Surfaces Stones Some Stones
(eg woodland, agricultural field, vacant lot etc...)
Vegatation Mixed Forest, Mostly Deciduous Upland
Landform Kame Terrace
Position on landscape See attached Sketch
Distances from:

Open Water Body >100 feet Drainage Way 100± feet
Possible Wet Area >100 feet Property Line 80± feet
Drinking Water Well >100 feet Other:
feet

Deep Observation Hole Log

Hole # 121-2 NB Suface El. 146.1

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-10	A	sl	10YR 3/3	-	mvfr
10-29	B	sl	10YR 4/6	@ 27"	mvfr, 5-10% cobbles
29-92	C	sl	2.5YR 5/4	10% 2.5YR 5/8	mvfr, roots stop, 5-10% cobbles

Parent Material (geologic) Ice Contact Outwash Depth to Bedrock: >92"
Depth to Groundwater: Standing Water in the Hole 92" Weeping from Pit Face: 38"
Estimated Seasonal High Groundwater in the Hole 27"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 139 Amesbury Line Road
Haverhill, MA
(235 Amesbury Line Road - Access)

On-Site Review

Deep Hole #: 121-3 Date: 01 08 21 Time: 12:00 PM Weather: Clear 34°
Location (identify on site plan) See Attached Sketch
Land Use Wooded Slope (%) 2%-4% Surfaces Stones Some Stones
(eg woodland, agricultural field, vacant lot etc...)
Vegatation Mixed Forest, Mostly Deciduous Upland
Landform Kame Terrace
Position on landscape See attached Sketch
Distances from:
Open Water Body >100 feet Drainage Way 100+ feet
Possible Wet Area >100 feet Property Line 100± feet
Drinking Water Well >100 feet Other:
feet

Deep Observation Hole Log

Hole # 121-3 NB Suface El. 152.9

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-10	A	sl	10YR 3/3	-	mvfr
10-28	B	sl	10YR 4/6	@ 27"	mvfr, roots stop, 5-10% pebbles
28-72	C	sl	2.5YR 5/4	10% 2.5YR 5/6	mvfr, 20% cobbles

Parent Material (geologic) Ice Contact Outwash Depth to Bedrock: >72"
Depth to Groundwater: Standing Water in the Hole 72" Weeping from Pit Face: 27"
Estimated Seasonal High Groundwater in the Hole 27"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 139 Amesbury Line Road
Haverhill, MA
(235 Amesbury Line Road - Access)

On-Site Review

Deep Hole #: 121-4 Date: 01/08/21 Time: 1:00 PM Weather: Clear 36°
Location (identify on site plan) See Attached Sketch
Land Use Wooded Slope (%) 2%-4% Surfaces Stones Some Stones
(eg woodland, agricultural field, vacant lot etc…)
Vegatation Mixed Forest, Mostly Deciduous Upland
Landform Kame Terrace
Position on landscape See attached Sketch
Distances from:

Open Water Body >100 feet Drainage Way 100± feet
Possible Wet Area >100 feet Property Line 80± feet
Drinking Water Well >100 feet Other:
feet

Deep Observation Hole Log					
Hole # 121-4		NB			Suface El. 138.1
Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-10	A	sl	10YR 3/3	-	mvfr
10-24	B	sl	10YR 4/6	-	mvfr, 5% pebbles
24-100	C	ls	10YR 5/1	@ 25" 10% 2.5YR 4/6	20% cobbles

Parent Material (geologic) Ice Contact Outwash Depth to Bedrock: >100"
Depth to Groundwater: Standing Water in the Hole n/a Weeping from Pit Face: 27"
Estimated Seasonal High Groundwater in the Hole 25"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 139 Amesbury Line Road
Haverhill, MA
(235 Amesbury Line Road - Access)

On-Site Review

Deep Hole #: 121-5 Date: 01 08 21 Time: 1:50 PM Weather: Clear 36°
Location (identify on site plan) See Attached Sketch
Land Use Wooded Slope (%) 2%-4% Surfaces Stones Some Stones
(eg woodland, agricultural field, vacant lot etc…)
Vegatation Mixed Forest, Mostly Deciduous Upland
Landform Kame Terrace
Position on landscape See attached Sketch
Distances from:

Open Water Body >100 feet Drainage Way 100+ feet
Possible Wet Area >100 feet Property Line 100± feet
Drinking Water Well >100 feet Other:
feet

Deep Observation Hole Log					
Hole # 121-5	NB				Suface El 179.5
Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-9	A	1	10YR 3 4	-	mvfr
9-30	B	1	10YR 4 6	-	mvfr 5% cobbles
30-112	C	1	10YR 7 1	@ 27" 10% 2.5YR 4 6	

Parent Material (geologic) Ice Contact Outwash Depth to Bedrock: >112"
Depth to Groundwater: Standing Water in the Hole n a Weeping from Pit Face: 50"
Estimated Seasonal High Groundwater in the Hole 27"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 139 Amesbury Line Road
Haverhill, MA
(235 Amesbury Line Road - Access)

On-Site Review

Deep Hole #: 121-6 Date: 01 08 21 Time: 2:30 PM Weather: Clear 38°
Location (identify on site plan) See Attached Sketch
Land Use Wooded Slope (%) 2%-4% Surfaces Stones Some Stones
(eg woodland, agricultural field, vacant lot etc...)
Vegatation Mixed Forest, Mostly Deciduous Upland
Landform Kame Terrace
Position on landscape See attached Sketch
Distances from:

Open Water Body >100 feet Drainage Way 100± feet
Possible Wet Area >100 feet Property Line 100± feet
Drinking Water Well >100 feet Other:
feet

Deep Observation Hole Log					
Hole # 121-6	NB				Surface El. 147.3
Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-12	A	1	10YR 3 3	-	mvfr
12-30	B	1	10YR 4 6	@ 28"	mvfr, 5% cobbles
30-	C	1	2.5Y 4/4	10% 10YR 7/1 2.5YR 4 6	

Parent Material (geologic) Ice Contact Outwash Depth to Bedrock: >"
Depth to Groundwater: Standing Water in the Hole n a Weeping from Pit Face: 38"
Estimated Seasonal High Groundwater in the Hole 28"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot#: 139 Amesbury Line Road
Haverhill, MA

Determination for Seasonal High Water Table

Method Used:

- ☐ Depth observed standing in observation hole ____ inches ____
- ☐ Depth weeping from side of observation hole ____ inches ____
- ☑ Depth to soil mottles * inches See individual Reports
- ☐ Ground water adjustment ____ feet ____

Index Well Number ____ Reading Date ____ Index Well Level ____

Adjustment Factor ____ Adjusted Ground Water Level ____

Depth of Naturally Occuring Pervious Material

Does at least four feet of naturally occuring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes

If not, what is the depth of naturally occuring pervious material? ____ Feet

Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated, on the attached soil evaluation form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature ____ Date 4/8/2021

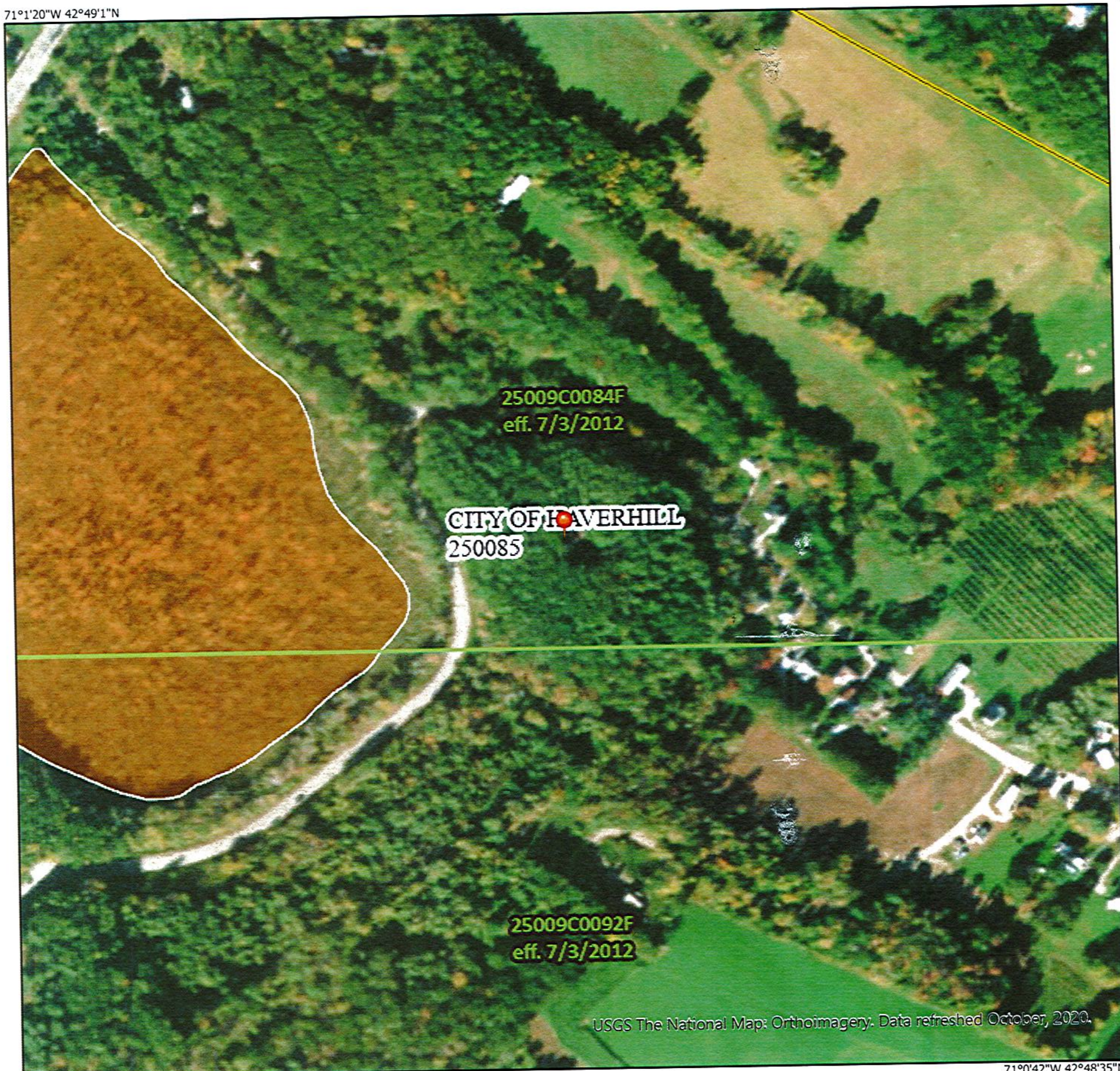
Notes: ____

Signature

National Flood Hazard Layer FIRMette

FEMA

71°1'20"W 42°49'1"N



71°0'42"W 42°48'35"N

Feet 0 250 500 1,000 1,500 2,000

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS	NO SCREEN	Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES	B 20.2 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
	8	Coastal Transect
	513	Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped

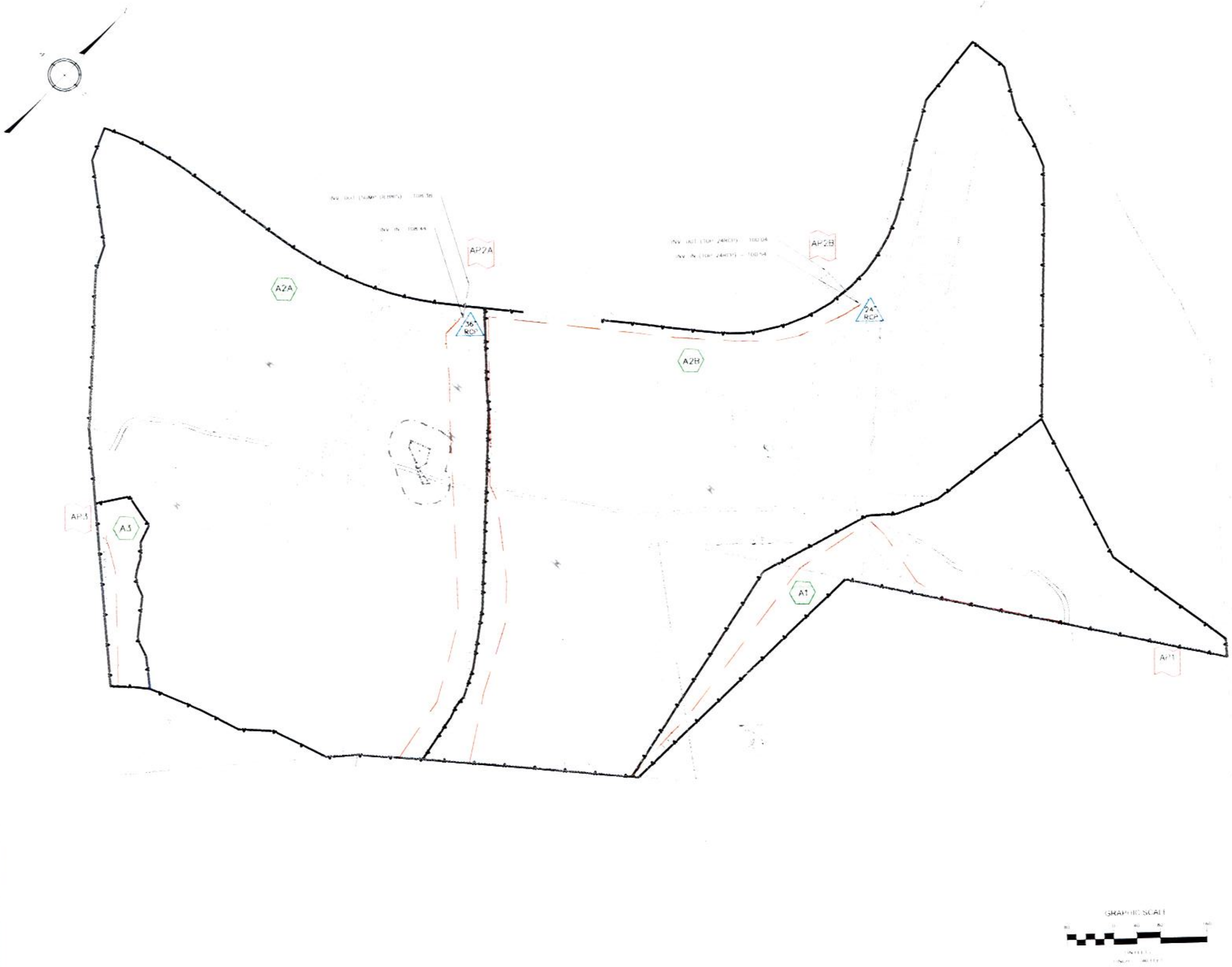
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/19/2020 at 10:45 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



LEGEND

DRAWING ISSUED FOR:

CONCEPT CONSTRUCTION

■ PERMIT CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION, LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES, DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION
1	8/16/2021	JFB	AEB	REVIEW COMMENTS & ADDED WETLAND AREAS

GPR Engineering Solutions for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.

39 MAIN STREET, SUITE 301, AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978.772.1590 FAX: 978.772.1591
www.gpr-inc.com

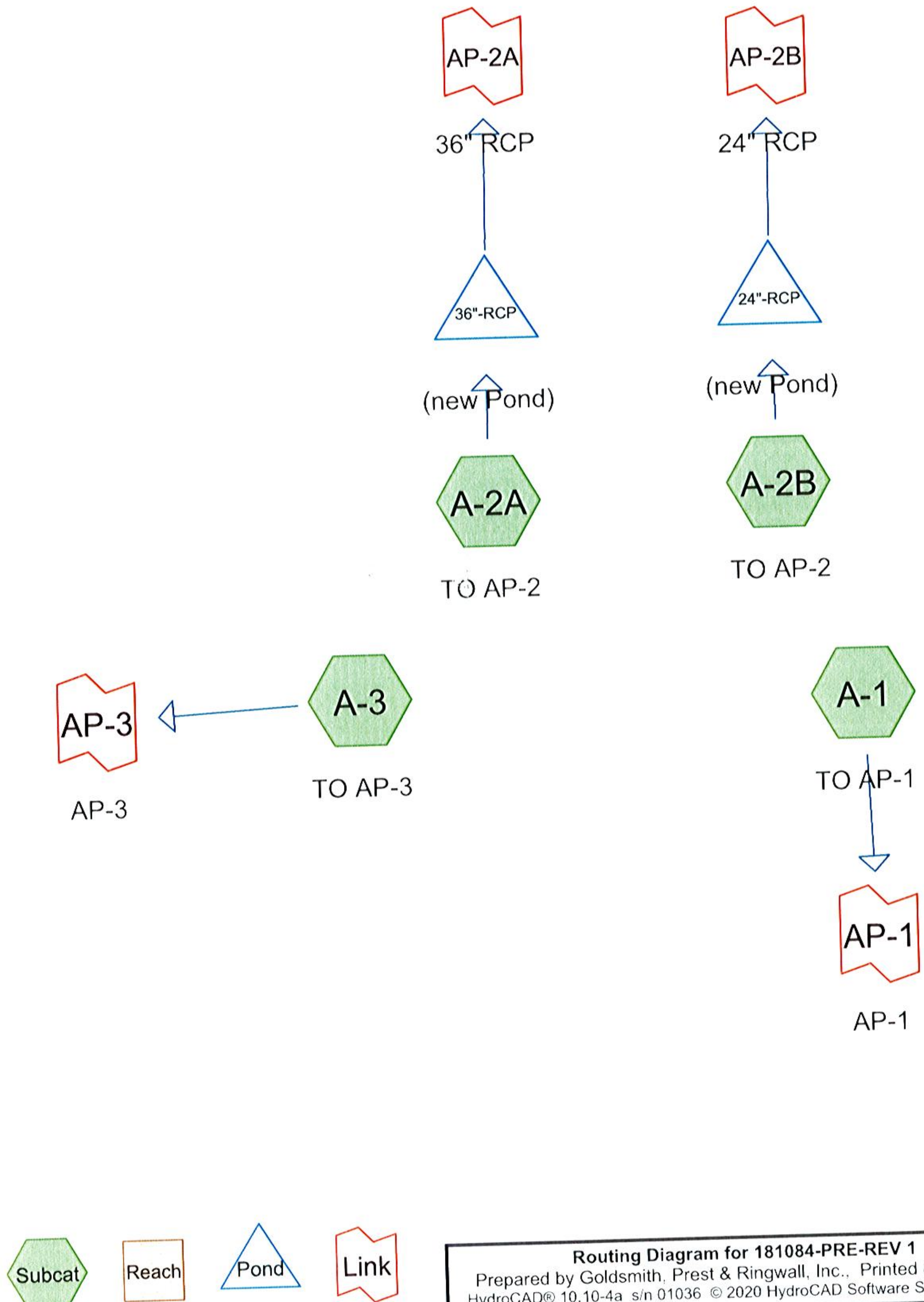
SOLAR PHOTOVOLTAIC PROJECT

WATERSHED MAP
PRE-DEVELOPMENT

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: AEB	DATE: APRIL 2021	JOB 181084	2 OF 3
CHK. BY: AEB			



Routing Diagram for 181084-PRE-REV 1
Prepared by Goldsmith, Prest & Ringwall, Inc., Printed 8/16/2021
HydroCAD® 10.10-4a s/n 01036 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	NRCC 24-hr	D	Default	24.00	1	3.15	2
2	10-Year	NRCC 24-hr	D	Default	24.00	1	4.83	2
3	100-Year	NRCC 24-hr	D	Default	24.00	1	8.94	2

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment A-1: TO AP-1	Runoff Area=145,471 sf 0.46% Impervious Runoff Depth=0.80" Flow Length=999' Tc=20.8 min CN=70 Runoff=1.6 cfs 9,688 cf
Subcatchment A-2A: TO AP-2	Runoff Area=537,274 sf 1.78% Impervious Runoff Depth=0.80" Flow Length=788' Tc=19.9 min CN=70 Runoff=6.2 cfs 35,780 cf
Subcatchment A-2B: TO AP-2	Runoff Area=595,445 sf 3.93% Impervious Runoff Depth=0.85" Flow Length=1,429' Tc=37.6 min CN=71 Runoff=5.3 cfs 42,088 cf
Subcatchment A-3: TO AP-3	Runoff Area=21,227 sf 0.00% Impervious Runoff Depth=0.80" Flow Length=259' Tc=14.8 min CN=70 Runoff=0.3 cfs 1,414 cf
Pond 24"-RCP: (new Pond)	Peak Elev=99.51' Storage=17 cf Inflow=5.3 cfs 42,088 cf 36.0" Round Culvert n=0.011 L=81.0' S=0.0062 '/' Outflow=5.3 cfs 42,086 cf
Pond 36"-RCP: (new Pond)	Peak Elev=110.85' Storage=8 cf Inflow=6.2 cfs 35,780 cf 36.0" Round Culvert n=0.011 L=57.0' S=0.0135 '/' Outflow=6.2 cfs 35,778 cf
Link AP-1: AP-1	Inflow=1.6 cfs 9,688 cf Primary=1.6 cfs 9,688 cf
Link AP-2A: 36" RCP	Inflow=6.2 cfs 35,778 cf Primary=6.2 cfs 35,778 cf
Link AP-2B: 24" RCP	Inflow=5.3 cfs 42,086 cf Primary=5.3 cfs 42,086 cf
Link AP-3: AP-3	Inflow=0.3 cfs 1,414 cf Primary=0.3 cfs 1,414 cf

Summary for Subcatchment A-1: TO AP-1

Runoff = 1.6 cfs @ 12.33 hrs, Volume= 9,688 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
9,812	39	>75% Grass cover, Good, HSG A
28,748	74	>75% Grass cover, Good, HSG C
4,836	96	Gravel surface, HSG C
288	98	Paved parking, HSG A
385	98	Roofs, HSG A
101,253	70	Woods, Good, HSG C
149	30	Woods, Good, HSG A
145,471	70	Weighted Average
144,798		99.54% Pervious Area
673		0.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	75	0.0690	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.3	85	0.0690	4.23		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	291	0.0690	4.23		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.3	151	0.1460	1.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.6	181	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.0	216	0.0320	0.89		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.8	999	Total			

Summary for Subcatchment A-2A: TO AP-2

Runoff = 6.2 cfs @ 12.32 hrs, Volume= 35,780 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
527,687	70	Woods, Good, HSG C
9,587	98	Paved parking, HSG C
537,274	70	Weighted Average
527,687		98.22% Pervious Area
9,587		1.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	75	0.0430	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.6	40	0.0430	1.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.8	136	0.0660	1.28		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	207	0.1010	1.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	294	0.1670	2.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	36	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.9	788	Total			

Summary for Subcatchment A-2B: TO AP-2

Runoff = 5.3 cfs @ 12.56 hrs, Volume= 42,088 cf, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
550,793	70	Woods, Good, HSG C
20,671	98	Paved parking, HSG C
21,260	74	>75% Grass cover, Good, HSG C
2,721	98	Roofs, HSG C
0	70	Woods, Good, HSG C
595,445	71	Weighted Average
572,053		96.07% Pervious Area
23,392		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	75	0.0300	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.5	26	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	303	0.0826	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.1	232	0.1420	1.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	53	0.1700	2.06		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	72	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.8	209	0.0144	0.60		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.4	234	0.0210	0.72		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.6	108	0.0190	0.69		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.6	61	0.0160	0.63		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	56	0.0890	1.49		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
37.6	1,429	Total			

Summary for Subcatchment A-3: TO AP-3

Runoff = 0.3 cfs @ 12.25 hrs, Volume= 1,414 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
21,227	70	Woods, Good, HSG C
21,227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	75	0.0440	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.7	106	0.0440	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	78	0.1790	2.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.8	259	Total			

Summary for Pond 24"-RCP: (new Pond)

Inflow Area = 595,445 sf, 3.93% Impervious, Inflow Depth = 0.85" for 2-Year event
Inflow = 5.3 cfs @ 12.56 hrs, Volume= 42,088 cf
Outflow = 5.3 cfs @ 12.56 hrs, Volume= 42,086 cf, Atten= 0%, Lag= 0.0 min
Primary = 5.3 cfs @ 12.56 hrs, Volume= 42,086 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 99.51' @ 12.56 hrs Surf.Area= 27 sf Storage= 17 cf

Plug-Flow detention time= 0.1 min calculated for 42,057 cf (100% of inflow)
Center-of-Mass det. time= 0.1 min (938.2 - 938.2)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	4,909 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1	3.0	0	0	1
99.00	15	22.0	7	7	41
100.00	42	31.0	27	34	87
101.00	79	37.0	60	94	134
102.00	189	60.0	130	224	318
103.00	809	120.0	463	687	1,182
104.00	1,937	205.0	1,333	2,019	3,387
105.00	3,963	302.0	2,890	4,909	7,308

Device	Routing	Invert	Outlet Devices
#1	Primary	98.54'	**36.0" Round Culvert** L= 81.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 98.54' / 98.04' S= 0.0062 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=5.3 cfs @ 12.56 hrs HW=99.51' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 5.3 cfs @ 2.65 fps)

Summary for Pond 36"-RCP: (new Pond)

Inflow Area = 537,274 sf, 1.78% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 6.2 cfs @ 12.32 hrs, Volume= 35,780 cf
Outflow = 6.2 cfs @ 12.32 hrs, Volume= 35,778 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.2 cfs @ 12.32 hrs, Volume= 35,778 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 110.85' @ 12.32 hrs Surf.Area= 9 sf Storage= 8 cf

Plug-Flow detention time= 0.2 min calculated for 35,778 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (926.2 - 926.2)

Volume	Invert	Avail.Storage	Storage Description
#1	109.00'	412 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
109.00	1	4.0	0	0	1
110.00	4	9.0	2	2	9
111.00	10	15.0	7	9	26
112.00	18	19.0	14	23	46
113.00	43	27.0	30	53	83
114.00	165	52.0	97	150	245
115.00	372	74.0	262	412	475

Device	Routing	Invert	Outlet Devices
#1	Primary	109.79'	**36.0" Round Culvert** L= 57.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.79' / 109.02' S= 0.0135 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=6.1 cfs @ 12.32 hrs HW=110.84' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 6.1 cfs @ 2.76 fps)

Summary for Link AP-1: AP-1

Inflow Area = 145,471 sf, 0.46% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 1.6 cfs @ 12.33 hrs, Volume= 9,688 cf
Primary = 1.6 cfs @ 12.33 hrs, Volume= 9,688 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2A: 36" RCP

Inflow Area = 537,274 sf, 1.78% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 6.2 cfs @ 12.32 hrs, Volume= 35,778 cf
Primary = 6.2 cfs @ 12.32 hrs, Volume= 35,778 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2B: 24" RCP

Inflow Area = 595,445 sf, 3.93% Impervious, Inflow Depth = 0.85" for 2-Year event
Inflow = 5.3 cfs @ 12.56 hrs, Volume= 42,086 cf
Primary = 5.3 cfs @ 12.56 hrs, Volume= 42,086 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-3: AP-3

Inflow Area =	21,227 sf,	0.00% Impervious, Inflow Depth = 0.80"	for 2-Year event
Inflow =	0.3 cfs @	12.25 hrs, Volume=	1,414 cf
Primary =	0.3 cfs @	12.25 hrs, Volume=	1,414 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment A-1: TO AP-1	Runoff Area=145,471 sf 0.46% Impervious Runoff Depth=1.91" Flow Length=999' Tc=20.8 min CN=70 Runoff=4.3 cfs 23,168 cf
Subcatchment A-2A: TO AP-2	Runoff Area=537,274 sf 1.78% Impervious Runoff Depth=1.91" Flow Length=788' Tc=19.9 min CN=70 Runoff=16.3 cfs 85,569 cf
Subcatchment A-2B: TO AP-2	Runoff Area=595,445 sf 3.93% Impervious Runoff Depth=1.99" Flow Length=1,429' Tc=37.6 min CN=71 Runoff=13.5 cfs 98,688 cf
Subcatchment A-3: TO AP-3	Runoff Area=21,227 sf 0.00% Impervious Runoff Depth=1.91" Flow Length=259' Tc=14.8 min CN=70 Runoff=0.7 cfs 3,381 cf
Pond 24"-RCP: (new Pond)	Peak Elev=100.18' Storage=42 cf Inflow=13.5 cfs 98,688 cf 36.0" Round Culvert n=0.011 L=81.0' S=0.0062 '/' Outflow=13.5 cfs 98,686 cf
Pond 36"-RCP: (new Pond)	Peak Elev=111.61' Storage=17 cf Inflow=16.3 cfs 85,569 cf 36.0" Round Culvert n=0.011 L=57.0' S=0.0135 '/' Outflow=16.3 cfs 85,567 cf
Link AP-1: AP-1	Inflow=4.3 cfs 23,168 cf Primary=4.3 cfs 23,168 cf
Link AP-2A: 36" RCP	Inflow=16.3 cfs 85,567 cf Primary=16.3 cfs 85,567 cf
Link AP-2B: 24" RCP	Inflow=13.5 cfs 98,686 cf Primary=13.5 cfs 98,686 cf
Link AP-3: AP-3	Inflow=0.7 cfs 3,381 cf Primary=0.7 cfs 3,381 cf

Summary for Subcatchment A-1: TO AP-1

Runoff = 4.3 cfs @ 12.31 hrs, Volume= 23,168 cf, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
9,812	39	>75% Grass cover, Good, HSG A
28,748	74	>75% Grass cover, Good, HSG C
4,836	96	Gravel surface, HSG C
288	98	Paved parking, HSG A
385	98	Roofs, HSG A
101,253	70	Woods, Good, HSG C
149	30	Woods, Good, HSG A
145,471	70	Weighted Average
144,798		99.54% Pervious Area
673		0.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	75	0.0690	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.3	85	0.0690	4.23		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	291	0.0690	4.23		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.3	151	0.1460	1.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.6	181	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.0	216	0.0320	0.89		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.8	999	Total			

Summary for Subcatchment A-2A: TO AP-2

Runoff = 16.3 cfs @ 12.30 hrs, Volume= 85,569 cf, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
527,687	70	Woods, Good, HSG C
9,587	98	Paved parking, HSG C
537,274	70	Weighted Average
527,687		98.22% Pervious Area
9,587		1.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	75	0.0430	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.6	40	0.0430	1.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.8	136	0.0660	1.28		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	207	0.1010	1.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	294	0.1670	2.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	36	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.9	788	Total			

Summary for Subcatchment A-2B: TO AP-2

Runoff = 13.5 cfs @ 12.53 hrs, Volume= 98,688 cf, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
550,793	70	Woods, Good, HSG C
20,671	98	Paved parking, HSG C
21,260	74	>75% Grass cover, Good, HSG C
2,721	98	Roofs, HSG C
0	70	Woods, Good, HSG C
595,445	71	Weighted Average
572,053		96.07% Pervious Area
23,392		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	75	0.0300	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.5	26	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	303	0.0826	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.1	232	0.1420	1.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	53	0.1700	2.06		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	72	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.8	209	0.0144	0.60		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.4	234	0.0210	0.72		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.6	108	0.0190	0.69		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.6	61	0.0160	0.63		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	56	0.0890	1.49		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
37.6	1,429	Total			

Summary for Subcatchment A-3: TO AP-3

Runoff = 0.7 cfs @ 12.24 hrs, Volume= 3,381 cf, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
21,227	70	Woods, Good, HSG C
21,227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	75	0.0440	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.7	106	0.0440	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	78	0.1790	2.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.8	259	Total			

Summary for Pond 24"-RCP: (new Pond)

Inflow Area =	595,445 sf,	3.93% Impervious, Inflow Depth = 1.99"	for 10-Year event
Inflow =	13.5 cfs @ 12.53 hrs, Volume=	98,688 cf	
Outflow =	13.5 cfs @ 12.53 hrs, Volume=	98,686 cf,	Atten= 0%, Lag= 0.1 min
Primary =	13.5 cfs @ 12.53 hrs, Volume=	98,686 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.18' @ 12.53 hrs Surf.Area= 48 sf Storage= 42 cf

Plug-Flow detention time= 0.8 min calculated for 98,686 cf (100% of inflow)
Center-of-Mass det. time= 0.1 min (905.2 - 905.1)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	4,909 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1	3.0	0	0	1
99.00	15	22.0	7	7	41
100.00	42	31.0	27	34	87
101.00	79	37.0	60	94	134
102.00	189	60.0	130	224	318
103.00	809	120.0	463	687	1,182
104.00	1,937	205.0	1,333	2,019	3,387
105.00	3,963	302.0	2,890	4,909	7,308

Device	Routing	Invert	Outlet Devices
#1	Primary	98.54'	**36.0" Round Culvert** L= 81.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 98.54' / 98.04' S= 0.0062 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=13.5 cfs @ 12.53 hrs HW=100.18' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Barrel Controls 13.5 cfs @ 4.94 fps)

Summary for Pond 36"-RCP: (new Pond)

Inflow Area =	537,274 sf,	1.78% Impervious, Inflow Depth = 1.91"	for 10-Year event
Inflow =	16.3 cfs @ 12.30 hrs, Volume=	85,569 cf	
Outflow =	16.3 cfs @ 12.30 hrs, Volume=	85,567 cf,	Atten= 0%, Lag= 0.0 min
Primary =	16.3 cfs @ 12.30 hrs, Volume=	85,567 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 111.61' @ 12.30 hrs Surf.Area= 15 sf Storage= 17 cf

Plug-Flow detention time= 0.0 min calculated for 85,508 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (892.0 - 892.0)

Volume	Invert	Avail.Storage	Storage Description
#1	109.00'	412 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
109.00	1	4.0	0	0	1
110.00	4	9.0	2	2	9
111.00	10	15.0	7	9	26
112.00	18	19.0	14	23	46
113.00	43	27.0	30	53	83
114.00	165	52.0	97	150	245
115.00	372	74.0	262	412	475

Device	Routing	Invert	Outlet Devices
#1	Primary	109.79'	**36.0" Round Culvert** L= 57.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.79' / 109.02' S= 0.0135 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=16.2 cfs @ 12.30 hrs HW=111.61' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 16.2 cfs @ 3.62 fps)

Summary for Link AP-1: AP-1

Inflow Area = 145,471 sf, 0.46% Impervious, Inflow Depth = 1.91" for 10-Year event
Inflow = 4.3 cfs @ 12.31 hrs, Volume= 23,168 cf
Primary = 4.3 cfs @ 12.31 hrs, Volume= 23,168 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2A: 36" RCP

Inflow Area = 537,274 sf, 1.78% Impervious, Inflow Depth = 1.91" for 10-Year event
Inflow = 16.3 cfs @ 12.30 hrs, Volume= 85,567 cf
Primary = 16.3 cfs @ 12.30 hrs, Volume= 85,567 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2B: 24" RCP

Inflow Area = 595,445 sf, 3.93% Impervious, Inflow Depth = 1.99" for 10-Year event
Inflow = 13.5 cfs @ 12.53 hrs, Volume= 98,686 cf
Primary = 13.5 cfs @ 12.53 hrs, Volume= 98,686 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-3: AP-3

Inflow Area =	21,227 sf,	0.00% Impervious,	Inflow Depth = 1.91"	for 10-Year event
Inflow =	0.7 cfs @	12.24 hrs, Volume=	3,381 cf	
Primary =	0.7 cfs @	12.24 hrs, Volume=	3,381 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment A-1: TO AP-1
Runoff Area=145,471 sf 0.46% Impervious Runoff Depth=5.28"
Flow Length=999' Tc=20.8 min CN=70 Runoff=12.2 cfs 64,033 cf

Subcatchment A-2A: TO AP-2
Runoff Area=537,274 sf 1.78% Impervious Runoff Depth=5.28"
Flow Length=788' Tc=19.9 min CN=70 Runoff=45.8 cfs 236,497 cf

Subcatchment A-2B: TO AP-2
Runoff Area=595,445 sf 3.93% Impervious Runoff Depth=5.41"
Flow Length=1,429' Tc=37.6 min CN=71 Runoff=37.5 cfs 268,209 cf

Subcatchment A-3: TO AP-3
Runoff Area=21,227 sf 0.00% Impervious Runoff Depth=5.28"
Flow Length=259' Tc=14.8 min CN=70 Runoff=2.1 cfs 9,344 cf

Pond 24"-RCP: (new Pond)
Peak Elev=101.99' Storage=221 cf Inflow=37.5 cfs 268,209 cf
36.0" Round Culvert n=0.011 L=81.0' S=0.0062 '/' Outflow=37.5 cfs 268,207 cf

Pond 36"-RCP: (new Pond)
Peak Elev=114.20' Storage=185 cf Inflow=45.8 cfs 236,497 cf
36.0" Round Culvert n=0.011 L=57.0' S=0.0135 '/' Outflow=45.8 cfs 236,495 cf

Link AP-1: AP-1
Inflow=12.2 cfs 64,033 cf
Primary=12.2 cfs 64,033 cf

Link AP-2A: 36" RCP
Inflow=45.8 cfs 236,495 cf
Primary=45.8 cfs 236,495 cf

Link AP-2B: 24" RCP
Inflow=37.5 cfs 268,207 cf
Primary=37.5 cfs 268,207 cf

Link AP-3: AP-3
Inflow=2.1 cfs 9,344 cf
Primary=2.1 cfs 9,344 cf

Summary for Subcatchment A-1: TO AP-1

Runoff = 12.2 cfs @ 12.30 hrs, Volume= 64,033 cf, Depth= 5.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
9,812	39	>75% Grass cover, Good, HSG A
28,748	74	>75% Grass cover, Good, HSG C
4,836	96	Gravel surface, HSG C
288	98	Paved parking, HSG A
385	98	Roofs, HSG A
101,253	70	Woods, Good, HSG C
149	30	Woods, Good, HSG A
145,471	70	Weighted Average
144,798		99.54% Pervious Area
673		0.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	75	0.0690	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.3	85	0.0690	4.23		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	291	0.0690	4.23		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.3	151	0.1460	1.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.6	181	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.0	216	0.0320	0.89		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.8	999	Total			

Summary for Subcatchment A-2A: TO AP-2

Runoff = 45.8 cfs @ 12.29 hrs, Volume= 236,497 cf, Depth= 5.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
527,687	70	Woods, Good, HSG C
9,587	98	Paved parking, HSG C
537,274	70	Weighted Average
527,687		98.22% Pervious Area
9,587		1.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	75	0.0430	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.6	40	0.0430	1.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.8	136	0.0660	1.28		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	207	0.1010	1.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	294	0.1670	2.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	36	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.9	788	Total			

Summary for Subcatchment A-2B: TO AP-2

Runoff = 37.5 cfs @ 12.51 hrs, Volume= 268,209 cf, Depth= 5.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
550,793	70	Woods, Good, HSG C
20,671	98	Paved parking, HSG C
21,260	74	>75% Grass cover, Good, HSG C
2,721	98	Roofs, HSG C
0	70	Woods, Good, HSG C
595,445	71	Weighted Average
572,053		96.07% Pervious Area
23,392		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	75	0.0300	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.5	26	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	303	0.0826	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.1	232	0.1420	1.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	53	0.1700	2.06		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	72	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.8	209	0.0144	0.60		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.4	234	0.0210	0.72		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.6	108	0.0190	0.69		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.6	61	0.0160	0.63		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	56	0.0890	1.49		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
37.6	1,429	Total			

Summary for Subcatchment A-3: TO AP-3

Runoff = 2.1 cfs @ 12.23 hrs, Volume= 9,344 cf, Depth= 5.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
21,227	70	Woods, Good, HSG C
21,227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	75	0.0440	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.7	106	0.0440	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	78	0.1790	2.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.8	259	Total			

Summary for Pond 24"-RCP: (new Pond)

Inflow Area = 595,445 sf, 3.93% Impervious, Inflow Depth = 5.41" for 100-Year event
Inflow = 37.5 cfs @ 12.51 hrs, Volume= 268,209 cf
Outflow = 37.5 cfs @ 12.52 hrs, Volume= 268,207 cf, Atten= 0%, Lag= 0.4 min
Primary = 37.5 cfs @ 12.52 hrs, Volume= 268,207 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 101.99' @ 12.52 hrs Surf.Area= 187 sf Storage= 221 cf

Plug-Flow detention time= 0.8 min calculated for 268,207 cf (100% of inflow)
Center-of-Mass det. time= 0.1 min (867.9 - 867.9)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	4,909 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1	3.0	0	0	1
99.00	15	22.0	7	7	41
100.00	42	31.0	27	34	87
101.00	79	37.0	60	94	134
102.00	189	60.0	130	224	318
103.00	809	120.0	463	687	1,182
104.00	1,937	205.0	1,333	2,019	3,387
105.00	3,963	302.0	2,890	4,909	7,308

Device	Routing	Invert	Outlet Devices
#1	Primary	98.54'	**36.0" Round Culvert** L= 81.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 98.54' / 98.04' S= 0.0062 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=37.4 cfs @ 12.52 hrs HW=101.97' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 37.4 cfs @ 5.29 fps)

Summary for Pond 36"-RCP: (new Pond)

Inflow Area = 537,274 sf, 1.78% Impervious, Inflow Depth = 5.28" for 100-Year event
Inflow = 45.8 cfs @ 12.29 hrs, Volume= 236,497 cf
Outflow = 45.8 cfs @ 12.30 hrs, Volume= 236,495 cf, Atten= 0%, Lag= 0.4 min
Primary = 45.8 cfs @ 12.30 hrs, Volume= 236,495 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 114.20' @ 12.30 hrs Surf.Area= 199 sf Storage= 185 cf

Plug-Flow detention time= 0.0 min calculated for 236,331 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (854.2 - 854.1)

Volume	Invert	Avail.Storage	Storage Description
#1	109.00'	412 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
109.00	1	4.0	0	0	1
110.00	4	9.0	2	2	9
111.00	10	15.0	7	9	26
112.00	18	19.0	14	23	46
113.00	43	27.0	30	53	83
114.00	165	52.0	97	150	245
115.00	372	74.0	262	412	475

Device	Routing	Invert	Outlet Devices
#1	Primary	109.79'	**36.0" Round Culvert** L= 57.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.79' / 109.02' S= 0.0135 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=45.8 cfs @ 12.30 hrs HW=114.19' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 45.8 cfs @ 6.47 fps)

Summary for Link AP-1: AP-1

Inflow Area = 145,471 sf, 0.46% Impervious, Inflow Depth = 5.28" for 100-Year event
Inflow = 12.2 cfs @ 12.30 hrs, Volume= 64,033 cf
Primary = 12.2 cfs @ 12.30 hrs, Volume= 64,033 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2A: 36" RCP

Inflow Area = 537,274 sf, 1.78% Impervious, Inflow Depth = 5.28" for 100-Year event
Inflow = 45.8 cfs @ 12.30 hrs, Volume= 236,495 cf
Primary = 45.8 cfs @ 12.30 hrs, Volume= 236,495 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2B: 24" RCP

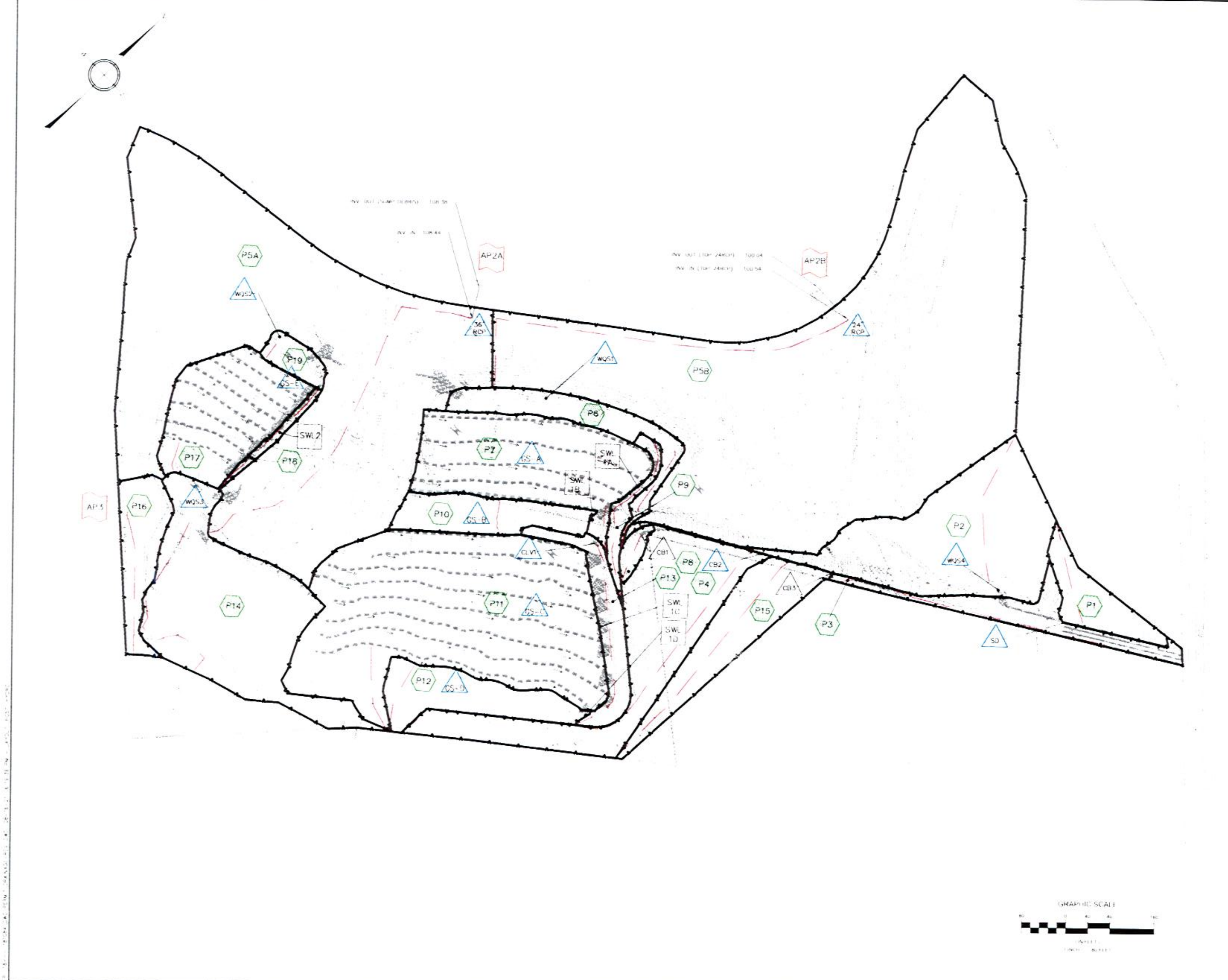
Inflow Area = 595,445 sf, 3.93% Impervious, Inflow Depth = 5.41" for 100-Year event
Inflow = 37.5 cfs @ 12.52 hrs, Volume= 268,207 cf
Primary = 37.5 cfs @ 12.52 hrs, Volume= 268,207 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-3: AP-3

Inflow Area =	21,227 sf,	0.00% Impervious,	Inflow Depth = 5.28"	for 100-Year event
Inflow =	2.1 cfs @	12.23 hrs, Volume=	9,344 cf	
Primary =	2.1 cfs @	12.23 hrs, Volume=	9,344 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs



LEGEND

P	WATERSHED
AP	ANALYSIS POINT
WQS	WATER QUALITY SWALE
SD	STONE DIAPHRAGM
GS	GRASS SWALE
CB	CATCHBASIN
RCP	REINFORCED CONCRETE PIPE
CLV3	CULVERT
SWL	SWALE
	TIME OF CONCENTRATION
	SUB-CATCHMENT WATERSHED DELINEATION

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SOLAR PHOTOVOLTAIC PROJECT

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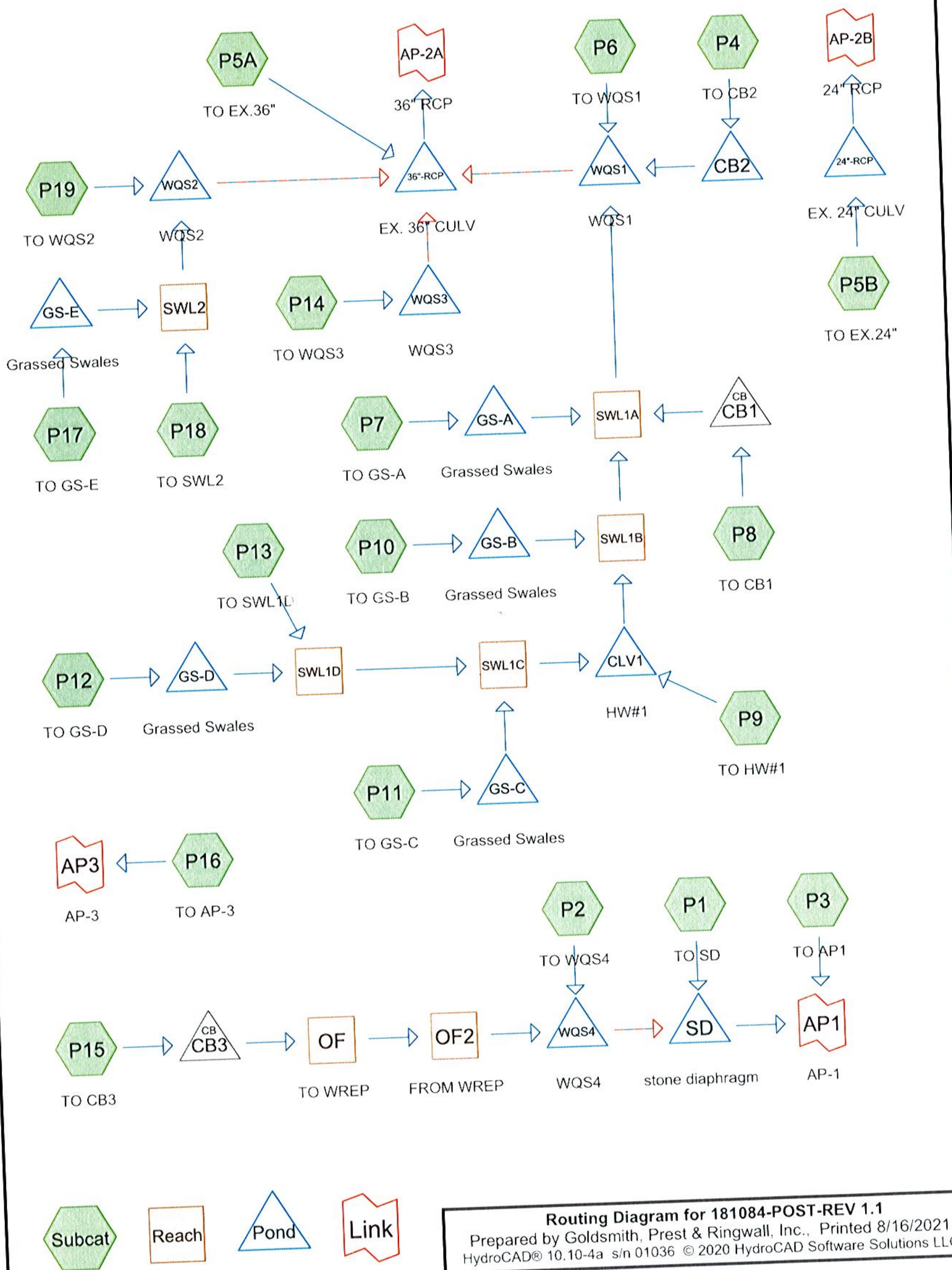
POST DEVELOPMENT

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
5207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JEB	DATE: APRIL 2021	JOB: TRT0184	5 OF 5
CHK. BY: KFB			



Routing Diagram for 181084-POST-REV 1.1

Prepared by Goldsmith, Prest & Ringwall, Inc., Printed 8/16/2021

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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	NRCC 24-hr	D	Default	24.00	1	3.15	2
2	10-Year	NRCC 24-hr	D	Default	24.00	1	4.83	2
3	100-Year	NRCC 24-hr	D	Default	24.00	1	8.94	2

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P1: TO SD Runoff Area=16,143 sf 4.08% Impervious Runoff Depth=0.54"
Flow Length=204' Tc=8.3 min CN=64 Runoff=0.2 cfs 721 cf

Subcatchment P10: TO GS-B Runoff Area=21,159 sf 1.51% Impervious Runoff Depth=1.18"
Flow Length=45' Slope=0.0667 '/' Tc=5.0 min CN=77 Runoff=0.6 cfs 2,074 cf

Subcatchment P11: TO GS-C Runoff Area=144,531 sf 0.00% Impervious Runoff Depth=1.06"
Flow Length=67' Tc=5.0 min CN=75 Runoff=3.8 cfs 12,770 cf

Subcatchment P12: TO GS-D Runoff Area=25,460 sf 0.00% Impervious Runoff Depth=1.43"
Flow Length=75' Tc=5.0 min CN=81 Runoff=0.9 cfs 3,034 cf

Subcatchment P13: TO SWL1D Runoff Area=17,550 sf 1.82% Impervious Runoff Depth=1.57"
Flow Length=327' Tc=5.0 min CN=83 Runoff=0.7 cfs 2,294 cf

Subcatchment P14: TO WQS3 Runoff Area=81,404 sf 0.49% Impervious Runoff Depth=1.12"
Flow Length=385' Tc=5.0 min CN=76 Runoff=2.3 cfs 7,580 cf

Subcatchment P15: TO CB3 Runoff Area=31,226 sf 0.00% Impervious Runoff Depth=1.12"
Flow Length=550' Tc=13.4 min CN=76 Runoff=0.7 cfs 2,908 cf

Subcatchment P16: TO AP-3 Runoff Area=19,815 sf 0.00% Impervious Runoff Depth=0.85"
Flow Length=259' Tc=14.8 min CN=71 Runoff=0.3 cfs 1,401 cf

Subcatchment P17: TO GS-E Runoff Area=43,526 sf 0.00% Impervious Runoff Depth=1.00"
Flow Length=184' Tc=5.0 min CN=74 Runoff=1.1 cfs 3,644 cf

Subcatchment P18: TO SWL2 Runoff Area=3,212 sf 0.00% Impervious Runoff Depth=1.00"
Tc=5.0 min CN=74 Runoff=0.1 cfs 269 cf

Subcatchment P19: TO WQS2 Runoff Area=6,629 sf 0.00% Impervious Runoff Depth=1.00"
Flow Length=31' Slope=0.2260 '/' Tc=5.0 min CN=74 Runoff=0.2 cfs 555 cf

Subcatchment P2: TO WQS4 Runoff Area=75,884 sf 0.00% Impervious Runoff Depth=0.95"
Flow Length=285' Tc=9.3 min CN=73 Runoff=1.5 cfs 6,014 cf

Subcatchment P3: TO AP1 Runoff Area=19,706 sf 1.38% Impervious Runoff Depth=1.64"
Flow Length=498' Tc=6.6 min CN=84 Runoff=0.8 cfs 2,694 cf

Subcatchment P4: TO CB2 Runoff Area=66,052 sf 0.00% Impervious Runoff Depth=0.90"
Flow Length=824' Tc=16.4 min CN=72 Runoff=1.0 cfs 4,947 cf

Subcatchment P5A: TO EX.36" Runoff Area=273,835 sf 3.65% Impervious Runoff Depth=0.90"
Flow Length=691' Tc=16.5 min CN=72 Runoff=4.0 cfs 20,510 cf

Subcatchment P5B: TO EX.24" Runoff Area=359,530 sf 6.51% Impervious Runoff Depth=0.95"
Flow Length=783' Tc=19.6 min CN=73 Runoff=5.2 cfs 28,492 cf

Subcatchment P6: TO WQS1 Runoff Area=22,064 sf 0.00% Impervious Runoff Depth=1.00"
Flow Length=35' Slope=0.1700 '/' Tc=5.0 min CN=74 Runoff=0.5 cfs 1,847 cf

Subcatchment P7: TO GS-A Runoff Area=61,702 sf 0.00% Impervious Runoff Depth=1.00"
Flow Length=308' Tc=5.0 min CN=74 Runoff=1.5 cfs 5,166 cf

Subcatchment P8: TO CB1 Runoff Area=3,312 sf 0.00% Impervious Runoff Depth=1.00"
Flow Length=119' Slope=0.1180 '/' Tc=5.0 min CN=74 Runoff=0.1 cfs 277 cf

Subcatchment P9: TO HW#1 Runoff Area=6,677 sf 3.29% Impervious Runoff Depth=1.64"
Flow Length=267' Tc=5.0 min CN=84 Runoff=0.3 cfs 913 cf

Reach OF: TO WREP Avg. Flow Depth=0.05' Max Vel=1.02 fps Inflow=0.7 cfs 2,908 cf
n=0.035 L=180.0' S=0.0389 '/' Capacity=1,899.8 cfs Outflow=0.6 cfs 2,908 cf

Reach OF2: FROM WREP Avg. Flow Depth=0.28' Max Vel=2.62 fps Inflow=0.6 cfs 2,908 cf
n=0.035 L=126.0' S=0.0556 '/' Capacity=115.9 cfs Outflow=0.6 cfs 2,908 cf

Reach SWL1A: Avg. Flow Depth=0.12' Max Vel=3.47 fps Inflow=1.0 cfs 4,238 cf
n=0.035 L=157.0' S=0.1338 '/' Capacity=263.5 cfs Outflow=1.0 cfs 4,238 cf

Reach SWL1B: Avg. Flow Depth=0.11' Max Vel=3.85 fps Inflow=0.9 cfs 3,961 cf
n=0.035 L=20.0' S=0.2000 '/' Capacity=322.2 cfs Outflow=0.9 cfs 3,961 cf

Reach SWL1C: Avg. Flow Depth=0.12' Max Vel=2.47 fps Inflow=0.7 cfs 3,048 cf
n=0.035 L=301.0' S=0.0731 '/' Capacity=194.8 cfs Outflow=0.7 cfs 3,048 cf

Reach SWL1D: Avg. Flow Depth=0.10' Max Vel=2.92 fps Inflow=0.7 cfs 3,048 cf
n=0.035 L=25.0' S=0.1200 '/' Capacity=249.6 cfs Outflow=0.7 cfs 3,048 cf

Reach SWL2: Avg. Flow Depth=0.11' Max Vel=2.10 fps Inflow=0.1 cfs 269 cf
n=0.035 L=265.0' S=0.1245 '/' Capacity=173.6 cfs Outflow=0.1 cfs 269 cf

Pond 24"-RCP: EX. 24" CULV Peak Elev=99.51' Storage=17 cf Inflow=5.2 cfs 28,492 cf
36.0" Round Culvert n=0.011 L=81.0' S=0.0062 '/' Outflow=5.2 cfs 28,490 cf

Pond 36"-RCP: EX. 36" CULV Peak Elev=110.83' Storage=8 cf Inflow=6.0 cfs 39,263 cf
36.0" Round Culvert n=0.011 L=57.0' S=0.0135 '/' Outflow=6.0 cfs 39,261 cf

Pond CB1: Peak Elev=166.12' Inflow=0.1 cfs 277 cf
12.0" Round Culvert n=0.013 L=62.0' S=0.0081 '/' Outflow=0.1 cfs 277 cf

Pond CB2: Peak Elev=148.00' Storage=0 cf Inflow=1.0 cfs 4,947 cf
15.0" Round Culvert n=0.013 L=264.0' S=0.0049 '/' Outflow=1.0 cfs 4,947 cf

Pond CB3: Peak Elev=129.17' Inflow=0.7 cfs 2,908 cf
12.0" Round Culvert n=0.013 L=34.0' S=0.0118 '/' Outflow=0.7 cfs 2,908 cf

Pond CLV1: HW#1 Peak Elev=174.00' Storage=0 cf Inflow=0.9 cfs 3,961 cf
15.0" Round Culvert n=0.013 L=65.0' S=0.1231 '/' Outflow=0.9 cfs 3,961 cf

Pond GS-A: Grassed Swales	Peak Elev=166.33' Storage=5,166 cf Inflow=1.5 cfs 5,166 cf Outflow=0.0 cfs 0 cf
Pond GS-B: Grassed Swales	Peak Elev=170.69' Storage=2,074 cf Inflow=0.6 cfs 2,074 cf Outflow=0.0 cfs 0 cf
Pond GS-C: Grassed Swales	Peak Elev=196.42' Storage=12,770 cf Inflow=3.8 cfs 12,770 cf Outflow=0.0 cfs 0 cf
Pond GS-D: Grassed Swales	Peak Elev=200.02' Storage=2,332 cf Inflow=0.9 cfs 3,034 cf Outflow=0.0 cfs 755 cf
Pond GS-E: Grassed Swales	Peak Elev=179.75' Storage=3,644 cf Inflow=1.1 cfs 3,644 cf Outflow=0.0 cfs 0 cf
Pond SD: stone diaphragm	Peak Elev=110.02' Storage=209 cf Inflow=1.3 cfs 9,640 cf Outflow=1.4 cfs 9,433 cf
Pond WQS1: WQS1	Peak Elev=143.49' Storage=2,352 cf Inflow=2.2 cfs 11,033 cf Primary=1.5 cfs 10,556 cf Secondary=0.0 cfs 0 cf Outflow=1.5 cfs 10,556 cf
Pond WQS2: WQS2	Peak Elev=143.48' Storage=378 cf Inflow=0.2 cfs 824 cf Primary=0.0 cfs 753 cf Secondary=0.0 cfs 0 cf Outflow=0.0 cfs 753 cf
Pond WQS3: WQS3	Peak Elev=181.88' Storage=1,808 cf Inflow=2.3 cfs 7,580 cf Primary=0.6 cfs 7,444 cf Secondary=0.0 cfs 0 cf Outflow=0.6 cfs 7,444 cf
Pond WQS4: WQS4	Peak Elev=112.49' Storage=997 cf Inflow=2.0 cfs 8,921 cf Primary=1.2 cfs 8,919 cf Secondary=0.0 cfs 0 cf Outflow=1.2 cfs 8,919 cf
Link AP-2A: 36" RCP	Inflow=6.0 cfs 39,261 cf Primary=6.0 cfs 39,261 cf
Link AP-2B: 24" RCP	Inflow=5.2 cfs 28,490 cf Primary=5.2 cfs 28,490 cf
Link AP1: AP-1	Inflow=1.6 cfs 12,127 cf Primary=1.6 cfs 12,127 cf
Link AP3: AP-3	Inflow=0.3 cfs 1,401 cf Primary=0.3 cfs 1,401 cf

Summary for Subcatchment P1: TO SD

Runoff = 0.2 cfs @ 12.17 hrs, Volume= 721 cf, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
370	98	Roofs, HSG A
288	98	Paved parking, HSG A
4,843	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG C
7,790	74	>75% Grass cover, Good, HSG C
2,852	70	Woods, Good, HSG C
0	96	Gravel surface, HSG A
16,143	64	Weighted Average
15,485		95.92% Pervious Area
658		4.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	75	0.1540	0.16		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.2	28	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	46	0.1540	6.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	55	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	204	Total			

Summary for Subcatchment P10: TO GS-B

Runoff = 0.6 cfs @ 12.12 hrs, Volume= 2,074 cf, Depth= 1.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
18,619	74	>75% Grass cover, Good, HSG C
2,220	96	Gravel surface, HSG C
320	98	Unconnected pavement, HSG C
21,159	77	Weighted Average
20,839		98.49% Pervious Area
320		1.51% Impervious Area
320		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	45	0.0667	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	45	Total			

Summary for Subcatchment P11: TO GS-C

Runoff = 3.8 cfs @ 12.12 hrs, Volume= 12,770 cf, Depth= 1.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
140,163	74	>75% Grass cover, Good, HSG C
3,993	96	Gravel surface, HSG C
375	70	Woods, Good, HSG C
144,531	75	Weighted Average
144,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0310	1.29		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
2.8	35	0.0570	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	67	Total			

Summary for Subcatchment P12: TO GS-D

Runoff = 0.9 cfs @ 12.12 hrs, Volume= 3,034 cf, Depth= 1.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
17,020	74	>75% Grass cover, Good, HSG C
7,895	96	Gravel surface, HSG C
442	70	Woods, Good, HSG C
103	74	>75% Grass cover, Good, HSG C
25,460	81	Weighted Average
25,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	28	0.0357	1.33		**Sheet Flow, grvl** Smooth surfaces n= 0.011 P2= 3.15"
3.2	31	0.0322	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.5	16	0.0050	0.54		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
1.0					**Direct Entry, 5.0 min.**
5.0	75	Total			

Summary for Subcatchment P13: TO SWL1D

Runoff = 0.7 cfs @ 12.12 hrs, Volume= 2,294 cf, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
10,471	74	>75% Grass cover, Good, HSG C
6,726	96	Gravel surface, HSG C
320	98	Unconnected pavement, HSG C
33	74	>75% Grass cover, Good, HSG C
17,550	83	Weighted Average
17,230		98.18% Pervious Area
320		1.82% Impervious Area
320		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	30	0.0630	1.70		**Sheet Flow, grvl** Smooth surfaces n= 0.011 P2= 3.15"
3.3	45	0.0630	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.0	12	0.0630	4.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	240	0.0750	4.41		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5					**Direct Entry, 5.0 min**
5.0	327	Total			

Summary for Subcatchment P14: TO WQS3

Runoff = 2.3 cfs @ 12.12 hrs, Volume= 7,580 cf, Depth= 1.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
7,914	96	Gravel surface, HSG C
70,819	74	>75% Grass cover, Good, HSG C
2,271	70	Woods, Good, HSG C
400	98	Unconnected pavement, HSG C
0	74	>75% Grass cover, Good, HSG C
81,404	76	Weighted Average
81,004		99.51% Pervious Area
400		0.49% Impervious Area
400		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	75	0.0200	1.29		**Sheet Flow, GRASS** Smooth surfaces n= 0.011 P2= 3.15"
1.3	175	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	135	0.1040	5.19		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.3					**Direct Entry, 5.0 MIN.**
5.0	385	Total			

Summary for Subcatchment P15: TO CB3

Runoff = 0.7 cfs @ 12.22 hrs, Volume= 2,908 cf, Depth= 1.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
12,202	74	>75% Grass cover, Good, HSG C
4,836	96	Gravel surface, HSG C
14,188	70	Woods, Good, HSG C
0	74	>75% Grass cover, Good, HSG C
31,226	76	Weighted Average
31,226		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	75	0.0680	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.1	87	0.0680	1.30		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	114	0.1500	6.24		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	81	0.1500	6.24		**Shallow Concentrated Flow, grvrl** Unpaved Kv= 16.1 fps
1.0	115	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	78	0.1030	5.17		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	550	Total			

Summary for Subcatchment P16: TO AP-3

Runoff = 0.3 cfs @ 12.25 hrs, Volume= 1,401 cf, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
12,429	70	Woods, Good, HSG C
7,386	74	>75% Grass cover, Good, HSG C
19,815	71	Weighted Average
19,815		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	75	0.0440	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.7	106	0.0440	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	78	0.1790	2.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.8	259	Total			

Summary for Subcatchment P17: TO GS-E

Runoff = 1.1 cfs @ 12.12 hrs, Volume= 3,644 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
43,526	74	>75% Grass cover, Good, HSG C
0	74	>75% Grass cover, Good, HSG C
43,526	74	Weighted Average
43,526		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	75	0.0800	2.24		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.3	49	0.0310	2.83		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.5	60	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.6					**Direct Entry, 5.0 MIN**
5.0	184	Total			

Summary for Subcatchment P18: TO SWL2

Runoff = 0.1 cfs @ 12.12 hrs, Volume= 269 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
3,212	74	>75% Grass cover, Good, HSG C
3,212		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5.0 MIN**

Summary for Subcatchment P19: TO WQS2

Runoff = 0.2 cfs @ 12.12 hrs, Volume= 555 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
6,629	74	>75% Grass cover, Good, HSG C
6,629		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	31	0.2260	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
3.5					**Direct Entry, MIN TC = 5.0 MIN**
5.0	31	Total			

Summary for Subcatchment P2: TO WQS4

Runoff = 1.5 cfs @ 12.17 hrs, Volume= 6,014 cf, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
55,955	70	Woods, Good, HSG C
13,098	74	>75% Grass cover, Good, HSG C
6,831	96	Gravel surface, HSG C
75,884	73	Weighted Average
75,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	75	0.1660	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.4	55	0.1660	2.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.5	142	0.0950	1.54		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	13	0.3300	9.25		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.3	285	Total			

Summary for Subcatchment P3: TO AP1

Runoff = 0.8 cfs @ 12.14 hrs, Volume= 2,694 cf, Depth= 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
1,002	39	>75% Grass cover, Good, HSG A
4,040	96	Gravel surface, HSG A
6,422	96	Gravel surface, HSG C
5,625	74	>75% Grass cover, Good, HSG C
2,270	70	Woods, Good, HSG C
76	30	Woods, Good, HSG A
256	98	Unconnected pavement, HSG C
15	98	Roofs, HSG A
19,706	84	Weighted Average
19,435		98.62% Pervious Area
271		1.38% Impervious Area
256		94.46% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	75	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.0	12	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	53	0.0750	4.41		**Shallow Concentrated Flow, GRVL** Unpaved Kv= 16.1 fps
2.3	358	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	498	Total			

Summary for Subcatchment P4: TO CB2

Runoff = 1.0 cfs @ 12.26 hrs, Volume= 4,947 cf, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
36,514	74	>75% Grass cover, Good, HSG C
29,013	70	Woods, Good, HSG C
525	96	Gravel surface, HSG C
66,052	72	Weighted Average
66,052		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	40	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.4	35	0.0350	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.3	290	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	90	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4	105	0.0670	1.29		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	211	0.1660	6.56		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	53	0.1510	6.26		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
16.4	824	Total			

Summary for Subcatchment P5A: TO EX.36"

Runoff = 4.0 cfs @ 12.26 hrs, Volume= 20,510 cf, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
0	96	Gravel surface, HSG C
187,867	70	Woods, Good, HSG C
75,981	74	>75% Grass cover, Good, HSG C
9,587	98	Paved parking, HSG C
400	98	Unconnected pavement, HSG C
273,835	72	Weighted Average
263,848		96.35% Pervious Area
9,987		3.65% Impervious Area
400		4.01% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	27	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
8.4	48	0.0490	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.8	54	0.0490	1.11		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.6	130	0.0770	1.39		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.5	305	0.1640	2.02		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.1	127	0.0390	0.99		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.5	691	Total			

Summary for Subcatchment P5B: TO EX.24"

Runoff = 5.2 cfs @ 12.30 hrs, Volume= 28,492 cf, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
5,494	96	Gravel surface, HSG C
277,852	70	Woods, Good, HSG C
52,653	74	>75% Grass cover, Good, HSG C
20,671	98	Paved parking, HSG C
2,721	98	Roofs, HSG C
139	74	>75% Grass cover, Good, HSG C
359,530	73	Weighted Average
336,138		93.49% Pervious Area
23,392		6.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	57	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.0	18	0.2500	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.3	52	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.9	209	0.0140	0.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.5	221	0.0180	0.67		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	117	0.0260	0.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.4	109	0.0700	1.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.6	783	Total			

Summary for Subcatchment P6: TO WQS1

Runoff = 0.5 cfs @ 12.12 hrs, Volume= 1,847 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
21,626	74	>75% Grass cover, Good, HSG C
438	96	Gravel surface, HSG C
22,064	74	Weighted Average
22,064		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	35	0.1700	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
3.2					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	35	Total			

Summary for Subcatchment P7: TO GS-A

Runoff = 1.5 cfs @ 12.12 hrs, Volume= 5,166 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
60,550	74	>75% Grass cover, Good, HSG C
1,152	96	Gravel surface, HSG C
0	98	Unconnected pavement, HSG C
61,702	74	Weighted Average
61,702		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	75	0.1050	2.50		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.1	39	0.1050	5.22		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.1	30	0.1000	5.09		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.3	86	0.0700	4.26		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.0	19	0.3330	9.29		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	59	0.1530	6.30		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.8					**Direct Entry, MIN TC = 5.0 MIN**
5.0	308	Total			

Summary for Subcatchment P8: TO CB1

Runoff = 0.1 cfs @ 12.12 hrs, Volume= 277 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
3,312	74	>75% Grass cover, Good, HSG C
3,312		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	75	0.1180	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.1	44	0.1180	5.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	119	Total			

Summary for Subcatchment P9: TO HW#1

Runoff = 0.3 cfs @ 12.12 hrs, Volume= 913 cf, Depth= 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
3,729	74	>75% Grass cover, Good, HSG C
0	98	Unconnected pavement, HSG C
2,728	96	Gravel surface, HSG C
220	98	Unconnected pavement, HSG C
6,677	84	Weighted Average
6,457		96.71% Pervious Area
220		3.29% Impervious Area
220		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	75	0.0950	2.40		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.2	61	0.0660	4.14		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.1	28	0.1430	6.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	103	0.2040	7.27		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	267	Total			

Summary for Reach OF: TO WREP

Inflow Area = 31,226 sf, 0.00% Impervious, Inflow Depth = 1.12" for 2-Year event
Inflow = 0.7 cfs @ 12.22 hrs, Volume= 2,908 cf
Outflow = 0.6 cfs @ 12.26 hrs, Volume= 2,908 cf, Atten= 4%, Lag= 2.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.02 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 5.0 min

Peak Storage= 111 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.05' , Surface Width= 14.91'
Bank-Full Depth= 2.00' Flow Area= 220.0 sf, Capacity= 1,899.8 cfs

10.00' x 2.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 50.0 '/' Top Width= 210.00'
Length= 180.0' Slope= 0.0389 '/'
Inlet Invert= 129.00', Outlet Invert= 122.00'

‡

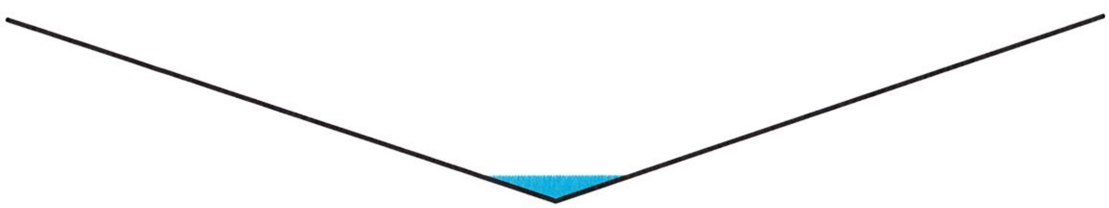
Summary for Reach OF2: FROM WREP

Inflow Area = 31,226 sf, 0.00% Impervious, Inflow Depth = 1.12" for 2-Year event
Inflow = 0.6 cfs @ 12.26 hrs, Volume= 2,908 cf
Outflow = 0.6 cfs @ 12.27 hrs, Volume= 2,908 cf, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.62 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 1.6 min

Peak Storage= 30 cf @ 12.27 hrs
Average Depth at Peak Storage= 0.28' , Surface Width= 1.70'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 115.9 cfs

0.00' x 2.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 126.0' Slope= 0.0556 '/'
Inlet Invert= 122.00', Outlet Invert= 115.00'



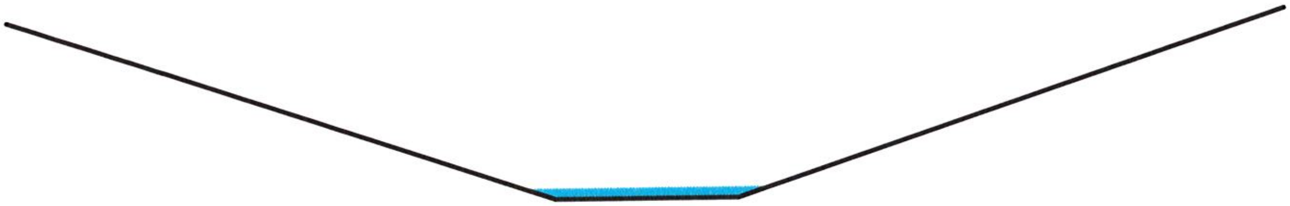
Summary for Reach SWL1A:

Inflow Area = 280,391 sf, 0.31% Impervious, Inflow Depth = 0.18" for 2-Year event
Inflow = 1.0 cfs @ 12.14 hrs, Volume= 4,238 cf
Outflow = 1.0 cfs @ 12.14 hrs, Volume= 4,238 cf, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.47 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 2.1 min

Peak Storage= 46 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.12' , Surface Width= 2.74'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 263.5 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 157.0' Slope= 0.1338 '/'
Inlet Invert= 166.00', Outlet Invert= 145.00'



Summary for Reach SWL1B:

Inflow Area = 215,377 sf, 0.40% Impervious, Inflow Depth = 0.22" for 2-Year event
Inflow = 0.9 cfs @ 12.14 hrs, Volume= 3,961 cf
Outflow = 0.9 cfs @ 12.14 hrs, Volume= 3,961 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.85 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.46 fps, Avg. Travel Time= 0.2 min

Peak Storage= 5 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.11' , Surface Width= 2.63'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 322.2 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 20.0' Slope= 0.2000 '/'
Inlet Invert= 170.00', Outlet Invert= 166.00'

Summary for Reach SWL1C:

Inflow Area = 187,541 sf, 0.17% Impervious, Inflow Depth = 0.20" for 2-Year event
Inflow = 0.7 cfs @ 12.12 hrs, Volume= 3,048 cf
Outflow = 0.7 cfs @ 12.14 hrs, Volume= 3,048 cf, Atten= 3%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.47 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.93 fps, Avg. Travel Time= 5.4 min

Peak Storage= 82 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.12' , Surface Width= 2.69'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 194.8 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 301.0' Slope= 0.0731 '/'
Inlet Invert= 196.00', Outlet Invert= 174.00'

Summary for Reach SWL1D:

Inflow Area =	43,010 sf, 0.74% Impervious,	Inflow Depth = 0.85" for 2-Year event
Inflow =	0.7 cfs @ 12.12 hrs, Volume=	3,048 cf
Outflow =	0.7 cfs @ 12.12 hrs, Volume=	3,048 cf, Atten= 1%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.92 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 0.4 min

Peak Storage= 6 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 2.62'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 249.6 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 25.0' Slope= 0.1200 '/'
Inlet Invert= 199.00', Outlet Invert= 196.00'

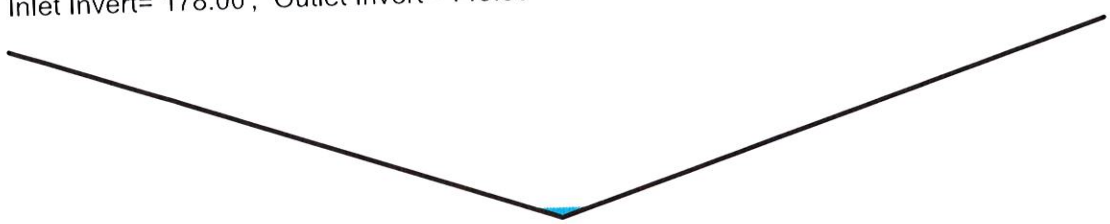
Summary for Reach SWL2:

Inflow Area =	46,738 sf, 0.00% Impervious,	Inflow Depth = 0.07" for 2-Year event
Inflow =	0.1 cfs @ 12.12 hrs, Volume=	269 cf
Outflow =	0.1 cfs @ 12.15 hrs, Volume=	269 cf, Atten= 5%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.10 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 4.3 min

Peak Storage= 10 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.11' , Surface Width= 0.65'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 173.6 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 265.0' Slope= 0.1245 '/'
Inlet Invert= 178.00', Outlet Invert= 145.00'



Summary for Pond 24"-RCP: EX. 24" CULV

Inflow Area =	359,530 sf,	6.51% Impervious,	Inflow Depth = 0.95"	for 2-Year event
Inflow =	5.2 cfs @	12.30 hrs, Volume=	28,492 cf	
Outflow =	5.2 cfs @	12.31 hrs, Volume=	28,490 cf,	Atten= 0%, Lag= 0.0 min
Primary =	5.2 cfs @	12.31 hrs, Volume=	28,490 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 99.51' @ 12.31 hrs Surf.Area= 27 sf Storage= 17 cf

Plug-Flow detention time= 0.1 min calculated for 28,470 cf (100% of inflow)
Center-of-Mass det. time= 0.1 min (913.0 - 912.9)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	4,909 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1	3.0	0	0	1
99.00	15	22.0	7	7	41
100.00	42	31.0	27	34	87
101.00	79	37.0	60	94	134
102.00	189	60.0	130	224	318
103.00	809	120.0	463	687	1,182
104.00	1,937	205.0	1,333	2,019	3,387
105.00	3,963	302.0	2,890	4,909	7,308

Device	Routing	Invert	Outlet Devices
#1	Primary	98.54'	**36.0" Round Culvert** L= 81.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 98.54' / 98.04' S= 0.0062 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=5.2 cfs @ 12.31 hrs HW=99.50' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 5.2 cfs @ 2.64 fps)

Summary for Pond 36"-RCP: EX. 36" CULV

Inflow Area = 777,113 sf, 1.45% Impervious, Inflow Depth = 0.61" for 2-Year event
Inflow = 6.0 cfs @ 12.28 hrs, Volume= 39,263 cf
Outflow = 6.0 cfs @ 12.28 hrs, Volume= 39,261 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.0 cfs @ 12.28 hrs, Volume= 39,261 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 110.83' @ 12.28 hrs Surf.Area= 9 sf Storage= 8 cf

Plug-Flow detention time= 0.1 min calculated for 39,234 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (965.9 - 965.9)

Volume	Invert	Avail.Storage	Storage Description
#1	109.00'	412 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
109.00	1	4.0	0	0	1
110.00	4	9.0	2	2	9
111.00	10	15.0	7	9	26
112.00	18	19.0	14	23	46
113.00	43	27.0	30	53	83
114.00	165	52.0	97	150	245
115.00	372	74.0	262	412	475

Device	Routing	Invert	Outlet Devices
#1	Primary	109.79'	**36.0" Round Culvert** L= 57.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.79' / 109.02' S= 0.0135 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=5.9 cfs @ 12.28 hrs HW=110.82' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 5.9 cfs @ 2.73 fps)

Summary for Pond CB1:

Inflow Area = 3,312 sf, 0.00% Impervious, Inflow Depth = 1.00" for 2-Year event
Inflow = 0.1 cfs @ 12.12 hrs, Volume= 277 cf
Outflow = 0.1 cfs @ 12.11 hrs, Volume= 277 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.1 cfs @ 12.11 hrs, Volume= 277 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.12' @ 12.19 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	164.00'	**12.0" Round Culvert** L= 62.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 164.00' / 163.50' S= 0.0081 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.0 cfs @ 12.11 hrs HW=166.10' TW=166.12' (Dynamic Tailwater)
↑—**1=Culvert** (Controls 0.0 cfs)

Summary for Pond CB2:

Inflow Area = 66,052 sf, 0.00% Impervious, Inflow Depth = 0.90" for 2-Year event
Inflow = 1.0 cfs @ 12.26 hrs, Volume= 4,947 cf
Outflow = 1.0 cfs @ 12.26 hrs, Volume= 4,947 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.0 cfs @ 12.26 hrs, Volume= 4,947 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 148.00' @ 0.00 hrs Surf.Area= 3 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	148.00'	119 cf	**Custom Stage Data (Irregular)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
148.00	3	6.0	0	0	3
149.00	50	25.0	22	22	52
150.00	154	44.0	97	119	162

Device	Routing	Invert	Outlet Devices
#1	Primary	144.30'	**15.0" Round Culvert** L= 264.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 144.30' / 143.00' S= 0.0049 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=0.0 cfs @ 12.26 hrs HW=148.00' TW=143.48' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.0 cfs of 6.7 cfs potential flow)

Summary for Pond CB3:

Inflow Area = 31,226 sf, 0.00% Impervious, Inflow Depth = 1.12" for 2-Year event
Inflow = 0.7 cfs @ 12.22 hrs, Volume= 2,908 cf
Outflow = 0.7 cfs @ 12.22 hrs, Volume= 2,908 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.7 cfs @ 12.22 hrs, Volume= 2,908 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 129.17' @ 12.23 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	128.50'	**12.0" Round Culvert** L= 34.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 128.50' / 128.10' S= 0.0118 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.6 cfs @ 12.22 hrs HW=129.16' TW=129.05' (Dynamic Tailwater)
↑—**1=Culvert** (Outlet Controls 0.6 cfs @ 1.60 fps)

Summary for Pond CLV1: HW#1

Inflow Area =	194,218 sf,	0.28% Impervious, Inflow Depth = 0.24"	for 2-Year event
Inflow =	0.9 cfs @	12.14 hrs, Volume=	3,961 cf
Outflow =	0.9 cfs @	12.14 hrs, Volume=	3,961 cf, Atten= 0%, Lag= 0.0 min
Primary =	0.9 cfs @	12.14 hrs, Volume=	3,961 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 174.00' @ 0.00 hrs Surf.Area= 274 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (929.2 - 929.2)

Volume	Invert	Avail.Storage	Storage Description
#1	174.00'	1,585 cf	**Custom Stage Data (Irregular)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
174.00	274	91.0	0	0	274
175.00	583	126.0	419	419	888
176.00	583	126.0	583	1,002	1,014
177.00	583	126.0	583	1,585	1,140

Device	Routing	Invert	Outlet Devices
#1	Primary	173.00'	**15.0" Round Culvert** L= 65.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 173.00' / 165.00' S= 0.1231 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=0.0 cfs @ 12.14 hrs HW=174.00' TW=170.10' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.0 cfs of 2.8 cfs potential flow)

Summary for Pond GS-A: Grassed Swales

Inflow Area =	61,702 sf,	0.00% Impervious, Inflow Depth = 1.00"	for 2-Year event
Inflow =	1.5 cfs @	12.12 hrs, Volume=	5,166 cf
Outflow =	0.0 cfs @	0.00 hrs, Volume=	0 cf, Atten= 100%, Lag= 0.0 min
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.33' @ 24.35 hrs Surf.Area= 10,414 sf Storage= 5,166 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	165.50'	24,032 cf	**Custom Stage Data (Conic)**Listed below x 4

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
165.50	434	0	0	434
166.00	1,736	506	506	1,737
166.50	3,038	1,178	1,685	3,042
167.00	4,340	1,835	3,520	4,348
167.50	5,642	2,488	6,008	5,656

Device	Routing	Invert	Outlet Devices
#1	Primary	167.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 4.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=165.50' TW=166.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond GS-B: Grassed Swales

Inflow Area =	21,159 sf,	1.51% Impervious,	Inflow Depth = 1.18"	for 2-Year event
Inflow =	0.6 cfs @	12.12 hrs, Volume=	2,074 cf	
Outflow =	0.0 cfs @	0.00 hrs, Volume=	0 cf,	Atten= 100%, Lag= 0.0 min
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 170.69' @ 24.35 hrs Surf.Area= 3,001 sf Storage= 2,074 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	169.50'	5,152 cf	**Custom Stage Data (Prismatic)**Listed below x 2

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
169.50	184	0	0
170.00	736	230	230
170.50	1,288	506	736
171.00	1,840	782	1,518
171.50	2,392	1,058	2,576

Device	Routing	Invert	Outlet Devices
#1	Primary	171.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 2.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88

2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=169.50' TW=170.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond GS-C: Grassed Swales

Inflow Area = 144,531 sf, 0.00% Impervious, Inflow Depth = 1.06" for 2-Year event
Inflow = 3.8 cfs @ 12.12 hrs, Volume= 12,770 cf
Outflow = 0.0 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 196.42' @ 24.35 hrs Surf.Area= 23,358 sf Storage= 12,770 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	195.50'	50,064 cf	**Custom Stage Data (Prismatic)**Listed below x 8

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
195.50	447	0	0
196.00	1,788	559	559
196.50	3,129	1,229	1,788
197.00	4,470	1,900	3,688
197.50	5,811	2,570	6,258

Device	Routing	Invert	Outlet Devices
#1	Primary	197.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 7.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=195.50' TW=196.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond GS-D: Grassed Swales

Inflow Area = 25,460 sf, 0.00% Impervious, Inflow Depth = 1.43" for 2-Year event
Inflow = 0.9 cfs @ 12.12 hrs, Volume= 3,034 cf
Outflow = 0.0 cfs @ 17.35 hrs, Volume= 755 cf, Atten= 96%, Lag= 313.8 min
Primary = 0.0 cfs @ 17.35 hrs, Volume= 755 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 200.02' @ 17.35 hrs Surf.Area= 2,838 sf Storage= 2,332 cf

Plug-Flow detention time= 525.3 min calculated for 755 cf (25% of inflow)

Center-of-Mass det. time= 350.8 min (1,217.3 - 866.5)

Volume	Invert	Avail.Storage	Storage Description
#1	198.50'	3,890 cf	**Custom Stage Data (Conic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
198.50	281	0	0	281
199.00	1,124	328	328	1,125
199.50	1,967	763	1,091	1,971
200.00	2,810	1,188	2,279	2,818
200.50	3,653	1,611	3,890	3,667

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 17.35 hrs HW=200.02' TW=199.02' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.0 cfs @ 0.33 fps)

Summary for Pond GS-E: Grassed Swales

Inflow Area =	43,526 sf,	0.00% Impervious,	Inflow Depth = 1.00"	for 2-Year event
Inflow =	1.1 cfs @	12.12 hrs, Volume=	3,644 cf	
Outflow =	0.0 cfs @	0.00 hrs, Volume=	0 cf,	Atten= 100%, Lag= 0.0 min
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 179.75' @ 24.35 hrs Surf.Area= 6,664 sf Storage= 3,644 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	178.50'	10,496 cf	**Custom Stage Data (Prismatic)**Listed below x 9

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
178.50	75	0	0
179.00	135	53	53
179.50	540	169	221
180.00	945	371	593
180.50	1,350	574	1,166

Device	Routing	Invert	Outlet Devices
#1	Primary	180.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 9.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

2.50 3.00 3.50
Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88
2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=178.50' TW=178.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond SD: stone diaphragm

Inflow Area =	123,253 sf, 0.53% Impervious,	Inflow Depth = 0.94"	for 2-Year event
Inflow =	1.3 cfs @ 12.34 hrs, Volume=	9,640 cf	
Outflow =	1.4 cfs @ 12.35 hrs, Volume=	9,433 cf,	Atten= 0%, Lag= 0.5 min
Primary =	1.4 cfs @ 12.35 hrs, Volume=	9,433 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 110.02' @ 12.35 hrs Surf.Area= 200 sf Storage= 209 cf
Flood Elev= 110.50' Surf.Area= 200 sf Storage= 247 cf

Plug-Flow detention time= 16.7 min calculated for 9,426 cf (98% of inflow)
Center-of-Mass det. time= 5.3 min (917.6 - 912.3)

Volume	Invert	Avail.Storage	Storage Description
#1	108.00'	169 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) 500 cf Overall - 79 cf Embedded = 421 cf x 40.0% Voids
#2	108.30'	79 cf	**12.0" Round Pipe Storage** Inside #1 L= 100.0'
		247 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
108.00	200	0	0
110.50	200	500	500

Device	Routing	Invert	Outlet Devices
#1	Primary	110.00'	**195.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=1.4 cfs @ 12.35 hrs HW=110.02' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 1.4 cfs @ 0.37 fps)

Summary for Pond WQS1: WQS1

Inflow Area =	368,507 sf, 0.23% Impervious,	Inflow Depth = 0.36"	for 2-Year event
Inflow =	2.2 cfs @ 12.16 hrs, Volume=	11,033 cf	
Outflow =	1.5 cfs @ 12.32 hrs, Volume=	10,556 cf,	Atten= 33%, Lag= 9.8 min
Primary =	1.5 cfs @ 12.32 hrs, Volume=	10,556 cf	
Secondary =	0.0 cfs @ 0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 143.49' @ 12.32 hrs Surf.Area= 5,570 sf Storage= 2,352 cf
Flood Elev= 143.10' Surf.Area= 4,391 sf Storage= 425 cf

Plug-Flow detention time= 180.1 min calculated for 10,556 cf (96% of inflow)
Center-of-Mass det. time= 157.1 min (1,073.8 - 916.7)

Volume	Invert	Avail.Storage	Storage Description
#1	143.00'	14,736 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
143.00	4,110	838.0	0	0	4,110
144.00	7,342	863.0	5,648	5,648	7,599
145.00	10,953	882.0	9,088	14,736	10,378

Device	Routing	Invert	Outlet Devices
#1	Primary	139.50'	**15.0" Round Culvert OUTLET** L= 115.0' Ke= 0.500 Inlet / Outlet Invert= 139.50' / 136.50' S= 0.0261 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	143.10'	**3.0" Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	143.40'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#4	Secondary	144.50'	**10.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.5 cfs @ 12.32 hrs HW=143.49' TW=110.81' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 1.5 cfs of 10.8 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.1 cfs @ 2.46 fps)
  └─**3=TOP OVERFLOW WEIR** (Weir Controls 1.3 cfs @ 0.96 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=143.00' TW=109.00' (Dynamic Tailwater)
└─**4=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS2: WQS2

Inflow Area =	53,367 sf,	0.00% Impervious, Inflow Depth = 0.19"	for 2-Year event
Inflow =	0.2 cfs @	12.13 hrs, Volume=	824 cf
Outflow =	0.0 cfs @	14.84 hrs, Volume=	753 cf, Atten= 94%, Lag= 162.4 min
Primary =	0.0 cfs @	14.84 hrs, Volume=	753 cf
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 143.48' @ 14.84 hrs Surf.Area= 932 sf Storage= 378 cf
Flood Elev= 143.10' Surf.Area= 712 sf Storage= 69 cf

Plug-Flow detention time= 352.2 min calculated for 752 cf (91% of inflow)
Center-of-Mass det. time= 310.0 min (1,206.4 - 896.4)

Volume	Invert	Avail.Storage	Storage Description
#1	143.00'	2,575 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
143.00	659	196.0	0	0	659
144.00	1,283	225.0	954	954	1,653
145.00	1,984	251.0	1,621	2,575	2,666

Device	Routing	Invert	Outlet Devices
#1	Primary	141.25'	**15.0" Round Culvert OUTLET** L= 35.1' Ke= 0.500 Inlet / Outlet Invert= 141.25' / 139.50' S= 0.0499 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	143.10'	**1.0" Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	143.65'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#4	Secondary	144.50'	**6.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.0 cfs @ 14.84 hrs HW=143.48' TW=110.16' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 0.0 cfs of 7.5 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.0 cfs @ 2.79 fps)
  └─**3=TOP OVERFLOW WEIR** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=143.00' TW=109.00' (Dynamic Tailwater)
└─**4=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS3: WQS3

Inflow Area = 81,404 sf, 0.49% Impervious, Inflow Depth = 1.12" for 2-Year event
Inflow = 2.3 cfs @ 12.12 hrs, Volume= 7,580 cf
Outflow = 0.6 cfs @ 12.39 hrs, Volume= 7,444 cf, Atten= 75%, Lag= 16.3 min
Primary = 0.6 cfs @ 12.39 hrs, Volume= 7,444 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 181.88' @ 12.39 hrs Surf.Area= 2,976 sf Storage= 1,808 cf
Flood Elev= 181.10' Surf.Area= 1,420 sf Storage= 134 cf

Plug-Flow detention time= 53.8 min calculated for 7,444 cf (98% of inflow)
Center-of-Mass det. time= 43.7 min (930.7 - 887.0)

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	17,330 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
181.00	1,261	147.0	0	0	1,261
182.00	3,271	245.0	2,188	2,188	4,324
183.00	4,534	296.0	3,885	6,073	6,537
184.00	5,604	338.0	5,060	11,133	8,679
185.00	6,810	396.0	6,197	17,330	12,087

Device	Routing	Invert	Outlet Devices
#1	Primary	179.00'	**18.0" Round Culvert OUTLET** L= 89.1' Ke= 0.500 Inlet / Outlet Invert= 179.00' / 177.50' S= 0.0168 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	181.10'	**3.0" Vert. LOW FLOW OUTLET X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Device 1	181.90'	**3.0" Vert. MIDDLE ORIFICES X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	184.00'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#5	Secondary	184.50'	**10.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.6 cfs @ 12.39 hrs HW=181.88' TW=110.73' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 0.6 cfs of 12.4 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.6 cfs @ 3.89 fps)
  ├─**3=MIDDLE ORIFICES** (Controls 0.0 cfs)
  └─**4=TOP OVERFLOW WEIR** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=181.00' TW=109.00' (Dynamic Tailwater)
└─**5=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS4: WQS4

Inflow Area = 107,110 sf, 0.00% Impervious, Inflow Depth = 1.00" for 2-Year event
Inflow = 2.0 cfs @ 12.19 hrs, Volume= 8,921 cf
Outflow = 1.2 cfs @ 12.35 hrs, Volume= 8,919 cf, Atten= 37%, Lag= 9.4 min
Primary = 1.2 cfs @ 12.35 hrs, Volume= 8,919 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 112.49' @ 12.35 hrs Surf.Area= 1,716 sf Storage= 997 cf
Flood Elev= 111.30' Surf.Area= 43 sf Storage= 2 cf

Plug-Flow detention time= 7.3 min calculated for 8,913 cf (100% of inflow)
Center-of-Mass det. time= 7.2 min (909.7 - 902.5)

Volume	Invert	Avail.Storage	Storage Description
#1	111.20'	6,843 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
111.20	10	5.0	0	0	10
111.50	179	88.0	23	23	624
112.00	1,102	222.0	288	311	3,931
113.00	2,495	276.0	1,752	2,062	6,085
114.00	3,426	314.0	2,948	5,011	7,894
114.50	3,908	328.0	1,832	6,843	8,627

Device	Routing	Invert	Outlet Devices
#1	Primary	109.60'	**12.0" Round Culvert OUTLET** L= 134.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.60' / 108.30' S= 0.0097 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	111.30'	**6.0" W x 3.0" H Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	112.05'	**8.0" W x 15.0" H Vert. MIDDLE WEIR** C= 0.600 Limited to weir flow at low heads
#4	Device 1	113.30'	**48.0" x 48.0" Horiz. TOP WEIR** C= 0.600 Limited to weir flow at low heads
#5	Secondary	114.00'	**10.0' long x 7.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.40 2.52 2.70 2.68 2.68 2.67 2.66 2.65 2.65 2.65 2.66 2.65 2.66 2.68 2.70 2.73 2.78

Primary OutFlow Max=1.2 cfs @ 12.35 hrs HW=112.49' TW=110.02' (Dynamic Tailwater)
1=Culvert OUTLET (Passes 1.2 cfs of 4.0 cfs potential flow)
2=LOW FLOW OUTLET (Orifice Controls 0.6 cfs @ 4.97 fps)
3=MIDDLE WEIR (Orifice Controls 0.6 cfs @ 2.13 fps)
4=TOP WEIR (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=111.20' TW=108.00' (Dynamic Tailwater)
5=EMERGENCY SPILLWAY (Controls 0.0 cfs)

Summary for Link AP-2A: 36" RCP

Inflow Area = 777,113 sf, 1.45% Impervious, Inflow Depth = 0.61" for 2-Year event
Inflow = 6.0 cfs @ 12.28 hrs, Volume= 39,261 cf
Primary = 6.0 cfs @ 12.28 hrs, Volume= 39,261 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2B: 24" RCP

Inflow Area = 359,530 sf, 6.51% Impervious, Inflow Depth = 0.95" for 2-Year event
Inflow = 5.2 cfs @ 12.31 hrs, Volume= 28,490 cf
Primary = 5.2 cfs @ 12.31 hrs, Volume= 28,490 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP1: AP-1

Inflow Area =	142,959 sf,	0.65% Impervious,	Inflow Depth = 1.02"	for 2-Year event
Inflow =	1.6 cfs @	12.25 hrs, Volume=	12,127 cf	
Primary =	1.6 cfs @	12.25 hrs, Volume=	12,127 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP3: AP-3

Inflow Area =	19,815 sf,	0.00% Impervious,	Inflow Depth = 0.85"	for 2-Year event
Inflow =	0.3 cfs @	12.25 hrs, Volume=	1,401 cf	
Primary =	0.3 cfs @	12.25 hrs, Volume=	1,401 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P1: TO SD Runoff Area=16,143 sf 4.08% Impervious Runoff Depth=1.47"
Flow Length=204' Tc=8.3 min CN=64 Runoff=0.5 cfs 1,979 cf

Subcatchment P10: TO GS-B Runoff Area=21,159 sf 1.51% Impervious Runoff Depth=2.48"
Flow Length=45' Slope=0.0667 '/' Tc=5.0 min CN=77 Runoff=1.3 cfs 4,375 cf

Subcatchment P11: TO GS-C Runoff Area=144,531 sf 0.00% Impervious Runoff Depth=2.31"
Flow Length=67' Tc=5.0 min CN=75 Runoff=8.5 cfs 27,848 cf

Subcatchment P12: TO GS-D Runoff Area=25,460 sf 0.00% Impervious Runoff Depth=2.84"
Flow Length=75' Tc=5.0 min CN=81 Runoff=1.8 cfs 6,016 cf

Subcatchment P13: TO SWL1D Runoff Area=17,550 sf 1.82% Impervious Runoff Depth=3.02"
Flow Length=327' Tc=5.0 min CN=83 Runoff=1.3 cfs 4,418 cf

Subcatchment P14: TO WQS3 Runoff Area=81,404 sf 0.49% Impervious Runoff Depth=2.40"
Flow Length=385' Tc=5.0 min CN=76 Runoff=5.0 cfs 16,255 cf

Subcatchment P15: TO CB3 Runoff Area=31,226 sf 0.00% Impervious Runoff Depth=2.40"
Flow Length=550' Tc=13.4 min CN=76 Runoff=1.4 cfs 6,235 cf

Subcatchment P16: TO AP-3 Runoff Area=19,815 sf 0.00% Impervious Runoff Depth=1.99"
Flow Length=259' Tc=14.8 min CN=71 Runoff=0.7 cfs 3,284 cf

Subcatchment P17: TO GS-E Runoff Area=43,526 sf 0.00% Impervious Runoff Depth=2.23"
Flow Length=184' Tc=5.0 min CN=74 Runoff=2.5 cfs 8,086 cf

Subcatchment P18: TO SWL2 Runoff Area=3,212 sf 0.00% Impervious Runoff Depth=2.23"
Tc=5.0 min CN=74 Runoff=0.2 cfs 597 cf

Subcatchment P19: TO WQS2 Runoff Area=6,629 sf 0.00% Impervious Runoff Depth=2.23"
Flow Length=31' Slope=0.2260 '/' Tc=5.0 min CN=74 Runoff=0.4 cfs 1,232 cf

Subcatchment P2: TO WQS4 Runoff Area=75,884 sf 0.00% Impervious Runoff Depth=2.15"
Flow Length=285' Tc=9.3 min CN=73 Runoff=3.6 cfs 13,583 cf

Subcatchment P3: TO AP1 Runoff Area=19,706 sf 1.38% Impervious Runoff Depth=3.12"
Flow Length=498' Tc=6.6 min CN=84 Runoff=1.5 cfs 5,116 cf

Subcatchment P4: TO CB2 Runoff Area=66,052 sf 0.00% Impervious Runoff Depth=2.07"
Flow Length=824' Tc=16.4 min CN=72 Runoff=2.4 cfs 11,382 cf

Subcatchment P5A: TO EX.36" Runoff Area=273,835 sf 3.65% Impervious Runoff Depth=2.07"
Flow Length=691' Tc=16.5 min CN=72 Runoff=9.9 cfs 47,186 cf

Subcatchment P5B: TO EX.24" Runoff Area=359,530 sf 6.51% Impervious Runoff Depth=2.15"
Flow Length=783' Tc=19.6 min CN=73 Runoff=12.5 cfs 64,355 cf

Subcatchment P6: TO WQS1 Runoff Area=22,064 sf 0.00% Impervious Runoff Depth=2.23"
Flow Length=35' Slope=0.1700 '/' Tc=5.0 min CN=74 Runoff=1.2 cfs 4,099 cf

Subcatchment P7: TO GS-A Runoff Area=61,702 sf 0.00% Impervious Runoff Depth=2.23"
Flow Length=308' Tc=5.0 min CN=74 Runoff=3.5 cfs 11,463 cf

Subcatchment P8: TO CB1 Runoff Area=3,312 sf 0.00% Impervious Runoff Depth=2.23"
Flow Length=119' Slope=0.1180 '/' Tc=5.0 min CN=74 Runoff=0.2 cfs 615 cf

Subcatchment P9: TO HW#1 Runoff Area=6,677 sf 3.29% Impervious Runoff Depth=3.12"
Flow Length=267' Tc=5.0 min CN=84 Runoff=0.5 cfs 1,733 cf

Reach OF: TO WREP Avg. Flow Depth=0.08' Max Vel=1.30 fps Inflow=1.4 cfs 6,235 cf
n=0.035 L=180.0' S=0.0389 '/' Capacity=1,899.8 cfs Outflow=1.4 cfs 6,235 cf

Reach OF2: FROM WREP Avg. Flow Depth=0.38' Max Vel=3.20 fps Inflow=1.4 cfs 6,235 cf
n=0.035 L=126.0' S=0.0556 '/' Capacity=115.9 cfs Outflow=1.4 cfs 6,235 cf

Reach SWL1A: Avg. Flow Depth=0.18' Max Vel=4.30 fps Inflow=2.0 cfs 11,842 cf
n=0.035 L=157.0' S=0.1338 '/' Capacity=263.5 cfs Outflow=2.0 cfs 11,842 cf

Reach SWL1B: Avg. Flow Depth=0.15' Max Vel=4.76 fps Inflow=1.8 cfs 11,228 cf
n=0.035 L=20.0' S=0.2000 '/' Capacity=322.2 cfs Outflow=1.8 cfs 11,228 cf

Reach SWL1C: Avg. Flow Depth=0.17' Max Vel=3.06 fps Inflow=1.3 cfs 8,155 cf
n=0.035 L=301.0' S=0.0731 '/' Capacity=194.8 cfs Outflow=1.3 cfs 8,155 cf

Reach SWL1D: Avg. Flow Depth=0.15' Max Vel=3.63 fps Inflow=1.3 cfs 8,155 cf
n=0.035 L=25.0' S=0.1200 '/' Capacity=249.6 cfs Outflow=1.3 cfs 8,155 cf

Reach SWL2: Avg. Flow Depth=0.15' Max Vel=2.58 fps Inflow=0.2 cfs 3,351 cf
n=0.035 L=265.0' S=0.1245 '/' Capacity=173.6 cfs Outflow=0.2 cfs 3,351 cf

Pond 24"-RCP: EX. 24" CULV Peak Elev=100.11' Storage=39 cf Inflow=12.5 cfs 64,355 cf
36.0" Round Culvert n=0.011 L=81.0' S=0.0062 '/' Outflow=12.5 cfs 64,353 cf

Pond 36"-RCP: EX. 36" CULV Peak Elev=111.58' Storage=16 cf Inflow=15.8 cfs 94,661 cf
36.0" Round Culvert n=0.011 L=57.0' S=0.0135 '/' Outflow=15.8 cfs 94,660 cf

Pond CB1: Peak Elev=166.18' Inflow=0.2 cfs 615 cf
12.0" Round Culvert n=0.013 L=62.0' S=0.0081 '/' Outflow=0.2 cfs 614 cf

Pond CB2: Peak Elev=148.00' Storage=0 cf Inflow=2.4 cfs 11,382 cf
15.0" Round Culvert n=0.013 L=264.0' S=0.0049 '/' Outflow=2.4 cfs 11,382 cf

Pond CB3: Peak Elev=129.37' Inflow=1.4 cfs 6,235 cf
12.0" Round Culvert n=0.013 L=34.0' S=0.0118 '/' Outflow=1.4 cfs 6,235 cf

Pond CLV1: HW#1 Peak Elev=174.00' Storage=0 cf Inflow=1.8 cfs 9,889 cf
15.0" Round Culvert n=0.013 L=65.0' S=0.1231 '/' Outflow=1.8 cfs 9,889 cf

Pond GS-A: Grassed Swales	Peak Elev=166.82' Storage=11,463 cf Inflow=3.5 cfs 11,463 cf Outflow=0.0 cfs 0 cf
Pond GS-B: Grassed Swales	Peak Elev=171.02' Storage=3,100 cf Inflow=1.3 cfs 4,375 cf Outflow=0.1 cfs 1,339 cf
Pond GS-C: Grassed Swales	Peak Elev=196.95' Storage=27,848 cf Inflow=8.5 cfs 27,848 cf Outflow=0.0 cfs 0 cf
Pond GS-D: Grassed Swales	Peak Elev=200.10' Storage=2,601 cf Inflow=1.8 cfs 6,016 cf Outflow=0.5 cfs 3,737 cf
Pond GS-E: Grassed Swales	Peak Elev=180.01' Storage=5,429 cf Inflow=2.5 cfs 8,086 cf Outflow=0.1 cfs 2,754 cf
Pond SD: stone diaphragm	Peak Elev=110.03' Storage=210 cf Inflow=3.4 cfs 21,795 cf Outflow=3.4 cfs 21,588 cf
Pond WQS1: WQS1	Peak Elev=143.59' Storage=2,944 cf Inflow=4.9 cfs 27,323 cf Primary=4.5 cfs 26,846 cf Secondary=0.0 cfs 0 cf Outflow=4.5 cfs 26,846 cf
Pond WQS2: WQS2	Peak Elev=143.68' Storage=580 cf Inflow=0.5 cfs 4,582 cf Primary=0.3 cfs 4,511 cf Secondary=0.0 cfs 0 cf Outflow=0.3 cfs 4,511 cf
Pond WQS3: WQS3	Peak Elev=182.53' Storage=4,102 cf Inflow=5.0 cfs 16,255 cf Primary=1.3 cfs 16,119 cf Secondary=0.0 cfs 0 cf Outflow=1.3 cfs 16,119 cf
Pond WQS4: WQS4	Peak Elev=113.12' Storage=2,375 cf Inflow=4.7 cfs 19,818 cf Primary=3.2 cfs 19,816 cf Secondary=0.0 cfs 0 cf Outflow=3.2 cfs 19,816 cf
Link AP-2A: 36" RCP	Inflow=15.8 cfs 94,660 cf Primary=15.8 cfs 94,660 cf
Link AP-2B: 24" RCP	Inflow=12.5 cfs 64,353 cf Primary=12.5 cfs 64,353 cf
Link AP1: AP-1	Inflow=4.2 cfs 26,704 cf Primary=4.2 cfs 26,704 cf
Link AP3: AP-3	Inflow=0.7 cfs 3,284 cf Primary=0.7 cfs 3,284 cf

Summary for Subcatchment P1: TO SD

Runoff = 0.5 cfs @ 12.16 hrs, Volume= 1,979 cf, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
370	98	Roofs, HSG A
288	98	Paved parking, HSG A
4,843	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG C
7,790	74	>75% Grass cover, Good, HSG C
2,852	70	Woods, Good, HSG C
0	96	Gravel surface, HSG A
16,143	64	Weighted Average
15,485		95.92% Pervious Area
658		4.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	75	0.1540	0.16		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.2	28	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	46	0.1540	6.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	55	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	204	Total			

Summary for Subcatchment P10: TO GS-B

Runoff = 1.3 cfs @ 12.12 hrs, Volume= 4,375 cf, Depth= 2.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
18,619	74	>75% Grass cover, Good, HSG C
2,220	96	Gravel surface, HSG C
320	98	Unconnected pavement, HSG C
21,159	77	Weighted Average
20,839		98.49% Pervious Area
320		1.51% Impervious Area
320		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	45	0.0667	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	45	Total			

Summary for Subcatchment P11: TO GS-C

Runoff = 8.5 cfs @ 12.12 hrs, Volume= 27,848 cf, Depth= 2.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
140,163	74	>75% Grass cover, Good, HSG C
3,993	96	Gravel surface, HSG C
375	70	Woods, Good, HSG C
144,531	75	Weighted Average
144,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0310	1.29		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
2.8	35	0.0570	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	67	Total			

Summary for Subcatchment P12: TO GS-D

Runoff = 1.8 cfs @ 12.11 hrs, Volume= 6,016 cf, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
17,020	74	>75% Grass cover, Good, HSG C
7,895	96	Gravel surface, HSG C
442	70	Woods, Good, HSG C
103	74	>75% Grass cover, Good, HSG C
25,460	81	Weighted Average
25,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	28	0.0357	1.33		**Sheet Flow, grvl** Smooth surfaces n= 0.011 P2= 3.15"
3.2	31	0.0322	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.5	16	0.0050	0.54		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
1.0					**Direct Entry, 5.0 min.**
5.0	75	Total			

Summary for Subcatchment P13: TO SWL1D

Runoff = 1.3 cfs @ 12.11 hrs, Volume= 4,418 cf, Depth= 3.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
10,471	74	>75% Grass cover, Good, HSG C
6,726	96	Gravel surface, HSG C
320	98	Unconnected pavement, HSG C
33	74	>75% Grass cover, Good, HSG C
17,550	83	Weighted Average
17,230		98.18% Pervious Area
320		1.82% Impervious Area
320		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	30	0.0630	1.70		**Sheet Flow, grvl** Smooth surfaces n= 0.011 P2= 3.15"
3.3	45	0.0630	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.0	12	0.0630	4.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	240	0.0750	4.41		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5					**Direct Entry, 5.0 min**
5.0	327	Total			

Summary for Subcatchment P14: TO WQS3

Runoff = 5.0 cfs @ 12.12 hrs, Volume= 16,255 cf, Depth= 2.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
7,914	96	Gravel surface, HSG C
70,819	74	>75% Grass cover, Good, HSG C
2,271	70	Woods, Good, HSG C
400	98	Unconnected pavement, HSG C
0	74	>75% Grass cover, Good, HSG C
81,404	76	Weighted Average
81,004		99.51% Pervious Area
400		0.49% Impervious Area
400		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	75	0.0200	1.29		**Sheet Flow, GRASS** Smooth surfaces n= 0.011 P2= 3.15"
1.3	175	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	135	0.1040	5.19		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.3					**Direct Entry, 5.0 MIN.**
5.0	385	Total			

Summary for Subcatchment P15: TO CB3

Runoff = 1.4 cfs @ 12.22 hrs, Volume= 6,235 cf, Depth= 2.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
12,202	74	>75% Grass cover, Good, HSG C
4,836	96	Gravel surface, HSG C
14,188	70	Woods, Good, HSG C
0	74	>75% Grass cover, Good, HSG C
31,226	76	Weighted Average
31,226		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	75	0.0680	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.1	87	0.0680	1.30		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	114	0.1500	6.24		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	81	0.1500	6.24		**Shallow Concentrated Flow, grvrl** Unpaved Kv= 16.1 fps
1.0	115	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	78	0.1030	5.17		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	550	Total			

Summary for Subcatchment P16: TO AP-3

Runoff = 0.7 cfs @ 12.24 hrs, Volume= 3,284 cf, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
12,429	70	Woods, Good, HSG C
7,386	74	>75% Grass cover, Good, HSG C
19,815	71	Weighted Average
19,815		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	75	0.0440	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.7	106	0.0440	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	78	0.1790	2.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.8	259	Total			

Summary for Subcatchment P17: TO GS-E

Runoff = 2.5 cfs @ 12.12 hrs, Volume= 8,086 cf, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
43,526	74	>75% Grass cover, Good, HSG C
0	74	>75% Grass cover, Good, HSG C
43,526	74	Weighted Average
43,526		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	75	0.0800	2.24		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.3	49	0.0310	2.83		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.5	60	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.6					**Direct Entry, 5.0 MIN**
5.0	184	Total			

Summary for Subcatchment P18: TO SWL2

Runoff = 0.2 cfs @ 12.12 hrs, Volume= 597 cf, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
3,212	74	>75% Grass cover, Good, HSG C
3,212		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5.0 MIN**

Summary for Subcatchment P19: TO WQS2

Runoff = 0.4 cfs @ 12.12 hrs, Volume= 1,232 cf, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
6,629	74	>75% Grass cover, Good, HSG C
6,629		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	31	0.2260	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
3.5					**Direct Entry, MIN TC = 5.0 MIN**
5.0	31	Total			

Summary for Subcatchment P2: TO WQS4

Runoff = 3.6 cfs @ 12.17 hrs, Volume= 13,583 cf, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
55,955	70	Woods, Good, HSG C
13,098	74	>75% Grass cover, Good, HSG C
6,831	96	Gravel surface, HSG C
75,884	73	Weighted Average
75,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	75	0.1660	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.4	55	0.1660	2.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.5	142	0.0950	1.54		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	13	0.3300	9.25		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.3	285	Total			

Summary for Subcatchment P3: TO AP1

Runoff = 1.5 cfs @ 12.14 hrs, Volume= 5,116 cf, Depth= 3.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
1,002	39	>75% Grass cover, Good, HSG A
4,040	96	Gravel surface, HSG A
6,422	96	Gravel surface, HSG C
5,625	74	>75% Grass cover, Good, HSG C
2,270	70	Woods, Good, HSG C
76	30	Woods, Good, HSG A
256	98	Unconnected pavement, HSG C
15	98	Roofs, HSG A
19,706	84	Weighted Average
19,435		98.62% Pervious Area
271		1.38% Impervious Area
256		94.46% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	75	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.0	12	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	53	0.0750	4.41		**Shallow Concentrated Flow, GRVL** Unpaved Kv= 16.1 fps
2.3	358	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	498	Total			

Summary for Subcatchment P4: TO CB2

Runoff = 2.4 cfs @ 12.25 hrs, Volume= 11,382 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
36,514	74	>75% Grass cover, Good, HSG C
29,013	70	Woods, Good, HSG C
525	96	Gravel surface, HSG C
66,052	72	Weighted Average
66,052		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	40	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.4	35	0.0350	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.3	290	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	90	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4	105	0.0670	1.29		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	211	0.1660	6.56		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	53	0.1510	6.26		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
16.4	824	Total			

Summary for Subcatchment P5A: TO EX.36"

Runoff = 9.9 cfs @ 12.26 hrs, Volume= 47,186 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
0	96	Gravel surface, HSG C
187,867	70	Woods, Good, HSG C
75,981	74	>75% Grass cover, Good, HSG C
9,587	98	Paved parking, HSG C
400	98	Unconnected pavement, HSG C
273,835	72	Weighted Average
263,848		96.35% Pervious Area
9,987		3.65% Impervious Area
400		4.01% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	27	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
8.4	48	0.0490	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.8	54	0.0490	1.11		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.6	130	0.0770	1.39		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.5	305	0.1640	2.02		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.1	127	0.0390	0.99		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.5	691	Total			

Summary for Subcatchment P5B: TO EX.24"

Runoff = 12.5 cfs @ 12.29 hrs, Volume= 64,355 cf, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
5,494	96	Gravel surface, HSG C
277,852	70	Woods, Good, HSG C
52,653	74	>75% Grass cover, Good, HSG C
20,671	98	Paved parking, HSG C
2,721	98	Roofs, HSG C
139	74	>75% Grass cover, Good, HSG C
359,530	73	Weighted Average
336,138		93.49% Pervious Area
23,392		6.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	57	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.0	18	0.2500	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.3	52	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.9	209	0.0140	0.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.5	221	0.0180	0.67		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	117	0.0260	0.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.4	109	0.0700	1.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.6	783	Total			

Summary for Subcatchment P6: TO WQS1

Runoff = 1.2 cfs @ 12.12 hrs, Volume= 4,099 cf, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
21,626	74	>75% Grass cover, Good, HSG C
438	96	Gravel surface, HSG C
22,064	74	Weighted Average
22,064		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	35	0.1700	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
3.2					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	35	Total			

Summary for Subcatchment P7: TO GS-A

Runoff = 3.5 cfs @ 12.12 hrs, Volume= 11,463 cf, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
60,550	74	>75% Grass cover, Good, HSG C
1,152	96	Gravel surface, HSG C
0	98	Unconnected pavement, HSG C
61,702	74	Weighted Average
61,702		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	75	0.1050	2.50		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.1	39	0.1050	5.22		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.1	30	0.1000	5.09		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.3	86	0.0700	4.26		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.0	19	0.3330	9.29		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	59	0.1530	6.30		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.8					**Direct Entry, MIN TC = 5.0 MIN**
5.0	308	Total			

Summary for Subcatchment P8: TO CB1

Runoff = 0.2 cfs @ 12.12 hrs, Volume= 615 cf, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
3,312	74	>75% Grass cover, Good, HSG C
3,312		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	75	0.1180	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.1	44	0.1180	5.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	119	Total			

Summary for Subcatchment P9: TO HW#1

Runoff = 0.5 cfs @ 12.11 hrs, Volume= 1,733 cf, Depth= 3.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
3,729	74	>75% Grass cover, Good, HSG C
0	98	Unconnected pavement, HSG C
2,728	96	Gravel surface, HSG C
220	98	Unconnected pavement, HSG C
6,677	84	Weighted Average
6,457		96.71% Pervious Area
220		3.29% Impervious Area
220		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	75	0.0950	2.40		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.2	61	0.0660	4.14		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.1	28	0.1430	6.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	103	0.2040	7.27		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	267	Total			

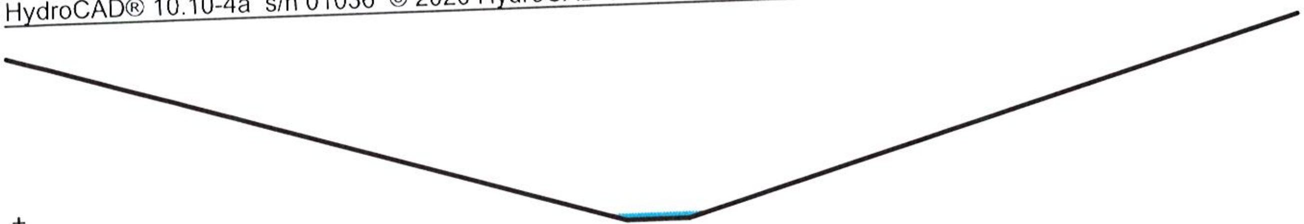
Summary for Reach OF: TO WREP

Inflow Area = 31,226 sf, 0.00% Impervious, Inflow Depth = 2.40" for 10-Year event
Inflow = 1.4 cfs @ 12.22 hrs, Volume= 6,235 cf
Outflow = 1.4 cfs @ 12.25 hrs, Volume= 6,235 cf, Atten= 3%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.30 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 4.9 min

Peak Storage= 194 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.08' , Surface Width= 17.76'
Bank-Full Depth= 2.00' Flow Area= 220.0 sf, Capacity= 1,899.8 cfs

10.00' x 2.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 50.0 '/' Top Width= 210.00'
Length= 180.0' Slope= 0.0389 '/'
Inlet Invert= 129.00', Outlet Invert= 122.00'



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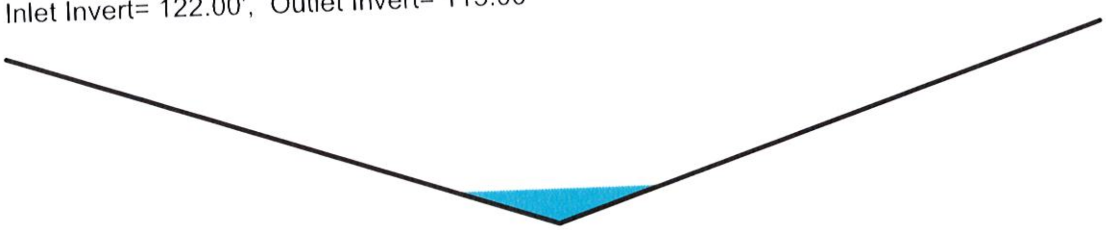
Summary for Reach OF2: FROM WREP

Inflow Area =	31,226 sf,	0.00% Impervious,	Inflow Depth = 2.40" for 10-Year event
Inflow =	1.4 cfs @	12.25 hrs, Volume=	6,235 cf
Outflow =	1.4 cfs @	12.26 hrs, Volume=	6,235 cf, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.20 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 1.4 min

Peak Storage= 55 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.38' , Surface Width= 2.29'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 115.9 cfs

0.00' x 2.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 126.0' Slope= 0.0556 '/'
Inlet Invert= 122.00', Outlet Invert= 115.00'



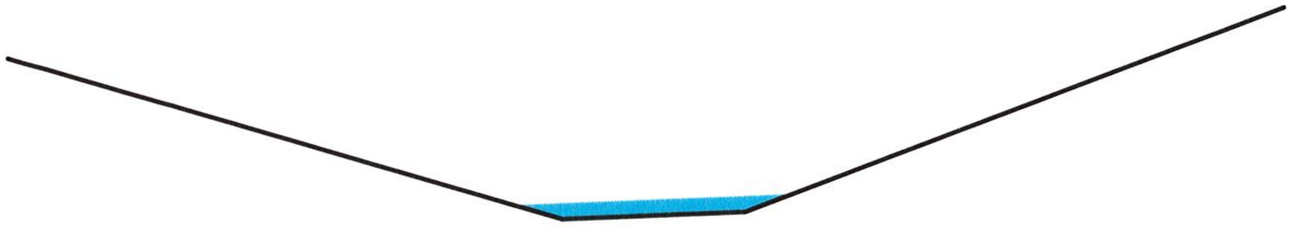
Summary for Reach SWL1A:

Inflow Area =	280,391 sf,	0.31% Impervious,	Inflow Depth = 0.51" for 10-Year event
Inflow =	2.0 cfs @	12.13 hrs, Volume=	11,842 cf
Outflow =	2.0 cfs @	12.14 hrs, Volume=	11,842 cf, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.30 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.57 fps, Avg. Travel Time= 1.7 min

Peak Storage= 72 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 3.08'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 263.5 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 157.0' Slope= 0.1338 '/'
Inlet Invert= 166.00', Outlet Invert= 145.00'



Summary for Reach SWL1B:

Inflow Area = 215,377 sf, 0.40% Impervious, Inflow Depth = 0.63" for 10-Year event
Inflow = 1.8 cfs @ 12.13 hrs, Volume= 11,228 cf
Outflow = 1.8 cfs @ 12.13 hrs, Volume= 11,228 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.76 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.82 fps, Avg. Travel Time= 0.2 min

Peak Storage= 7 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.15' , Surface Width= 2.91'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 322.2 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 20.0' Slope= 0.2000 '/'
Inlet Invert= 170.00', Outlet Invert= 166.00'

Summary for Reach SWL1C:

Inflow Area = 187,541 sf, 0.17% Impervious, Inflow Depth = 0.52" for 10-Year event
Inflow = 1.3 cfs @ 12.12 hrs, Volume= 8,155 cf
Outflow = 1.3 cfs @ 12.14 hrs, Volume= 8,155 cf, Atten= 3%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.06 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.14 fps, Avg. Travel Time= 4.4 min

Peak Storage= 127 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.17' , Surface Width= 3.01'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 194.8 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 301.0' Slope= 0.0731 '/'
Inlet Invert= 196.00', Outlet Invert= 174.00'

Summary for Reach SWL1D:

Inflow Area =	43,010 sf, 0.74% Impervious, Inflow Depth = 2.28"	for 10-Year event
Inflow =	1.3 cfs @ 12.11 hrs, Volume=	8,155 cf
Outflow =	1.3 cfs @ 12.12 hrs, Volume=	8,155 cf, Atten= 1%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.63 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 0.3 min

Peak Storage= 9 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.15' , Surface Width= 2.89'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 249.6 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 25.0' Slope= 0.1200 '/'
Inlet Invert= 199.00', Outlet Invert= 196.00'

Summary for Reach SWL2:

Inflow Area =	46,738 sf, 0.00% Impervious, Inflow Depth = 0.86"	for 10-Year event
Inflow =	0.2 cfs @ 12.12 hrs, Volume=	3,351 cf
Outflow =	0.2 cfs @ 12.14 hrs, Volume=	3,351 cf, Atten= 3%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.58 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.56 fps, Avg. Travel Time= 2.8 min

Peak Storage= 18 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.15' , Surface Width= 0.90'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 173.6 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 265.0' Slope= 0.1245 '/'
Inlet Invert= 178.00', Outlet Invert= 145.00'

Summary for Pond 24"-RCP: EX. 24" CULV

Inflow Area = 359,530 sf, 6.51% Impervious, Inflow Depth = 2.15" for 10-Year event
Inflow = 12.5 cfs @ 12.29 hrs, Volume= 64,355 cf
Outflow = 12.5 cfs @ 12.30 hrs, Volume= 64,353 cf, Atten= 0%, Lag= 0.1 min
Primary = 12.5 cfs @ 12.30 hrs, Volume= 64,353 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.11' @ 12.30 hrs Surf.Area= 45 sf Storage= 39 cf

Plug-Flow detention time= 0.8 min calculated for 64,353 cf (100% of inflow)
Center-of-Mass det. time= 0.1 min (881.9 - 881.8)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	4,909 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1	3.0	0	0	1
99.00	15	22.0	7	7	41
100.00	42	31.0	27	34	87
101.00	79	37.0	60	94	134
102.00	189	60.0	130	224	318
103.00	809	120.0	463	687	1,182
104.00	1,937	205.0	1,333	2,019	3,387
105.00	3,963	302.0	2,890	4,909	7,308

Device	Routing	Invert	Outlet Devices
#1	Primary	98.54'	**36.0" Round Culvert** L= 81.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 98.54' / 98.04' S= 0.0062 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=12.4 cfs @ 12.30 hrs HW=100.10' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Barrel Controls 12.4 cfs @ 4.86 fps)

Summary for Pond 36"-RCP: EX. 36" CULV

Inflow Area = 777,113 sf, 1.45% Impervious, Inflow Depth = 1.46" for 10-Year event
Inflow = 15.8 cfs @ 12.25 hrs, Volume= 94,661 cf
Outflow = 15.8 cfs @ 12.25 hrs, Volume= 94,660 cf, Atten= 0%, Lag= 0.0 min
Primary = 15.8 cfs @ 12.25 hrs, Volume= 94,660 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 111.58' @ 12.25 hrs Surf.Area= 14 sf Storage= 16 cf

Plug-Flow detention time= 0.1 min calculated for 94,594 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (921.3 - 921.3)

Volume	Invert	Avail.Storage	Storage Description
#1	109.00'	412 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
109.00	1	4.0	0	0	1
110.00	4	9.0	2	2	9
111.00	10	15.0	7	9	26
112.00	18	19.0	14	23	46
113.00	43	27.0	30	53	83
114.00	165	52.0	97	150	245
115.00	372	74.0	262	412	475

Device	Routing	Invert	Outlet Devices
#1	Primary	109.79'	**36.0" Round Culvert** L= 57.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.79' / 109.02' S= 0.0135 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=15.8 cfs @ 12.25 hrs HW=111.58' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 15.8 cfs @ 3.60 fps)

Summary for Pond CB1:

Inflow Area = 3,312 sf, 0.00% Impervious, Inflow Depth = 2.23" for 10-Year event
Inflow = 0.2 cfs @ 12.12 hrs, Volume= 615 cf
Outflow = 0.2 cfs @ 12.13 hrs, Volume= 614 cf, Atten= 0%, Lag= 0.5 min
Primary = 0.2 cfs @ 12.13 hrs, Volume= 614 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.18' @ 12.19 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	164.00'	**12.0" Round Culvert** L= 62.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 164.00' / 163.50' S= 0.0081 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.0 cfs @ 12.13 hrs HW=166.16' TW=166.17' (Dynamic Tailwater)
1=Culvert (Controls 0.0 cfs)

Summary for Pond CB2:

Inflow Area =	66,052 sf,	0.00% Impervious,	Inflow Depth = 2.07"	for 10-Year event
Inflow =	2.4 cfs @	12.25 hrs, Volume=	11,382 cf	
Outflow =	2.4 cfs @	12.25 hrs, Volume=	11,382 cf,	Atten= 0%, Lag= 0.0 min
Primary =	2.4 cfs @	12.25 hrs, Volume=	11,382 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 148.00' @ 0.00 hrs Surf.Area= 3 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	148.00'	119 cf	**Custom Stage Data (Irregular)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
148.00	3	6.0	0	0	3
149.00	50	25.0	22	22	52
150.00	154	44.0	97	119	162

Device	Routing	Invert	Outlet Devices
#1	Primary	144.30'	**15.0" Round Culvert** L= 264.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 144.30' / 143.00' S= 0.0049 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=0.0 cfs @ 12.25 hrs HW=148.00' TW=143.59' (Dynamic Tailwater)
1=Culvert (Passes 0.0 cfs of 6.7 cfs potential flow)

Summary for Pond CB3:

Inflow Area =	31,226 sf,	0.00% Impervious,	Inflow Depth = 2.40"	for 10-Year event
Inflow =	1.4 cfs @	12.22 hrs, Volume=	6,235 cf	
Outflow =	1.4 cfs @	12.22 hrs, Volume=	6,235 cf,	Atten= 0%, Lag= 0.0 min
Primary =	1.4 cfs @	12.22 hrs, Volume=	6,235 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 129.37' @ 12.22 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	128.50'	**12.0" Round Culvert** L= 34.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 128.50' / 128.10' S= 0.0118 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.4 cfs @ 12.22 hrs HW=129.37' TW=129.08' (Dynamic Tailwater)
└─1=**Culvert** (Outlet Controls 1.4 cfs @ 2.59 fps)

Summary for Pond CLV1: HW#1

Inflow Area =	194,218 sf,	0.28% Impervious,	Inflow Depth = 0.61" for 10-Year event
Inflow =	1.8 cfs @	12.13 hrs, Volume=	9,889 cf
Outflow =	1.8 cfs @	12.13 hrs, Volume=	9,889 cf, Atten= 0%, Lag= 0.0 min
Primary =	1.8 cfs @	12.13 hrs, Volume=	9,889 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 174.00' @ 12.15 hrs Surf.Area= 274 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (882.3 - 882.3)

Volume	Invert	Avail.Storage	Storage Description
#1	174.00'	1,585 cf	**Custom Stage Data (Irregular)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
174.00	274	91.0	0	0	274
175.00	583	126.0	419	419	888
176.00	583	126.0	583	1,002	1,014
177.00	583	126.0	583	1,585	1,140

Device	Routing	Invert	Outlet Devices
#1	Primary	173.00'	**15.0" Round Culvert** L= 65.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 173.00' / 165.00' S= 0.1231 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.8 cfs @ 12.13 hrs HW=174.00' TW=170.15' (Dynamic Tailwater)
└─1=**Culvert** (Inlet Controls 2.8 cfs @ 2.69 fps)

Summary for Pond GS-A: Grassed Swales

Inflow Area =	61,702 sf,	0.00% Impervious,	Inflow Depth = 2.23" for 10-Year event
Inflow =	3.5 cfs @	12.12 hrs, Volume=	11,463 cf
Outflow =	0.0 cfs @	0.00 hrs, Volume=	0 cf, Atten= 100%, Lag= 0.0 min
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.82' @ 24.35 hrs Surf.Area= 15,504 sf Storage= 11,463 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	165.50'	24,032 cf	**Custom Stage Data (Conic)**Listed below x 4

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
165.50	434	0	0	434
166.00	1,736	506	506	1,737
166.50	3,038	1,178	1,685	3,042
167.00	4,340	1,835	3,520	4,348
167.50	5,642	2,488	6,008	5,656

Device	Routing	Invert	Outlet Devices
#1	Primary	167.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 4.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=165.50' TW=166.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond GS-B: Grassed Swales

Inflow Area = 21,159 sf, 1.51% Impervious, Inflow Depth = 2.48" for 10-Year event
Inflow = 1.3 cfs @ 12.12 hrs, Volume= 4,375 cf
Outflow = 0.1 cfs @ 15.61 hrs, Volume= 1,339 cf, Atten= 96%, Lag= 209.6 min
Primary = 0.1 cfs @ 15.61 hrs, Volume= 1,339 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 171.02' @ 15.61 hrs Surf.Area= 3,714 sf Storage= 3,100 cf

Plug-Flow detention time= 457.9 min calculated for 1,338 cf (31% of inflow)
Center-of-Mass det. time= 291.8 min (1,146.8 - 855.0)

Volume	Invert	Avail.Storage	Storage Description
#1	169.50'	5,152 cf	**Custom Stage Data (Prismatic)**Listed below x 2

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
169.50	184	0	0
170.00	736	230	230
170.50	1,288	506	736
171.00	1,840	782	1,518
171.50	2,392	1,058	2,576

Device	Routing	Invert	Outlet Devices
#1	Primary	171.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 2.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88

2.85 3.07 3.20 3.32

Primary OutFlow Max=0.1 cfs @ 15.61 hrs HW=171.02' TW=170.04' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.1 cfs @ 0.31 fps)

Summary for Pond GS-C: Grassed Swales

Inflow Area =	144,531 sf,	0.00% Impervious,	Inflow Depth = 2.31" for 10-Year event
Inflow =	8.5 cfs @	12.12 hrs, Volume=	27,848 cf
Outflow =	0.0 cfs @	0.00 hrs, Volume=	0 cf, Atten= 100%, Lag= 0.0 min
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 196.95' @ 24.35 hrs Surf.Area= 34,592 sf Storage= 27,848 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	195.50'	50,064 cf	**Custom Stage Data (Prismatic)**Listed below x 8

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
195.50	447	0	0
196.00	1,788	559	559
196.50	3,129	1,229	1,788
197.00	4,470	1,900	3,688
197.50	5,811	2,570	6,258

Device	Routing	Invert	Outlet Devices
#1	Primary	197.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 7.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=195.50' TW=196.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond GS-D: Grassed Swales

Inflow Area =	25,460 sf,	0.00% Impervious,	Inflow Depth = 2.84" for 10-Year event
Inflow =	1.8 cfs @	12.11 hrs, Volume=	6,016 cf
Outflow =	0.5 cfs @	12.35 hrs, Volume=	3,737 cf, Atten= 74%, Lag= 14.2 min
Primary =	0.5 cfs @	12.35 hrs, Volume=	3,737 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 200.10' @ 12.35 hrs Surf.Area= 2,979 sf Storage= 2,601 cf

Plug-Flow detention time= 245.0 min calculated for 3,735 cf (62% of inflow)

Center-of-Mass det. time= 115.5 min (956.5 - 841.0)

Volume	Invert	Avail.Storage	Storage Description
#1	198.50'	3,890 cf	**Custom Stage Data (Conic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
198.50	281	0	0	281
199.00	1,124	328	328	1,125
199.50	1,967	763	1,091	1,971
200.00	2,810	1,188	2,279	2,818
200.50	3,653	1,611	3,890	3,667

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.5 cfs @ 12.35 hrs HW=200.10' TW=199.11' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 0.5 cfs @ 0.80 fps)

Summary for Pond GS-E: Grassed Swales

Inflow Area = 43,526 sf, 0.00% Impervious, Inflow Depth = 2.23" for 10-Year event
Inflow = 2.5 cfs @ 12.12 hrs, Volume= 8,086 cf
Outflow = 0.1 cfs @ 14.97 hrs, Volume= 2,754 cf, Atten= 95%, Lag= 171.2 min
Primary = 0.1 cfs @ 14.97 hrs, Volume= 2,754 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 180.01' @ 14.97 hrs Surf.Area= 8,573 sf Storage= 5,429 cf

Plug-Flow detention time= 425.8 min calculated for 2,752 cf (34% of inflow)
Center-of-Mass det. time= 262.2 min (1,127.2 - 865.0)

Volume	Invert	Avail.Storage	Storage Description
#1	178.50'	10,496 cf	**Custom Stage Data (Prismatic)**Listed below x 9

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
178.50	75	0	0
179.00	135	53	53
179.50	540	169	221
180.00	945	371	593
180.50	1,350	574	1,166

Device	Routing	Invert	Outlet Devices
#1	Primary	180.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 9.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

2.50 3.00 3.50
Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88
2.85 3.07 3.20 3.32

Primary OutFlow Max=0.1 cfs @ 14.97 hrs HW=180.01' TW=178.14' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.1 cfs @ 0.25 fps)

Summary for Pond SD: stone diaphragm

Inflow Area =	123,253 sf,	0.53% Impervious, Inflow Depth = 2.12"	for 10-Year event
Inflow =	3.4 cfs @	12.29 hrs, Volume=	21,795 cf
Outflow =	3.4 cfs @	12.29 hrs, Volume=	21,588 cf, Atten= 0%, Lag= 0.1 min
Primary =	3.4 cfs @	12.29 hrs, Volume=	21,588 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 110.03' @ 12.29 hrs Surf.Area= 200 sf Storage= 210 cf
Flood Elev= 110.50' Surf.Area= 200 sf Storage= 247 cf

Plug-Flow detention time= 8.8 min calculated for 21,588 cf (99% of inflow)
Center-of-Mass det. time= 3.1 min (885.9 - 882.8)

Volume	Invert	Avail.Storage	Storage Description
#1	108.00'	169 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 500 cf Overall - 79 cf Embedded = 421 cf x 40.0% Voids
#2	108.30'	79 cf	**12.0" Round Pipe Storage** Inside #1 L= 100.0'
		247 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
108.00	200	0	0
110.50	200	500	500

Device	Routing	Invert	Outlet Devices
#1	Primary	110.00'	**195.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.4 cfs @ 12.29 hrs HW=110.03' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 3.4 cfs @ 0.50 fps)

Summary for Pond WQS1: WQS1

Inflow Area =	368,507 sf,	0.23% Impervious, Inflow Depth = 0.89"	for 10-Year event
Inflow =	4.9 cfs @	12.15 hrs, Volume=	27,323 cf
Outflow =	4.5 cfs @	12.21 hrs, Volume=	26,846 cf, Atten= 8%, Lag= 3.4 min
Primary =	4.5 cfs @	12.21 hrs, Volume=	26,846 cf
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 143.59' @ 12.21 hrs Surf.Area= 5,908 sf Storage= 2,944 cf
Flood Elev= 143.10' Surf.Area= 4,391 sf Storage= 425 cf

Plug-Flow detention time= 79.2 min calculated for 26,827 cf (98% of inflow)
Center-of-Mass det. time= 71.0 min (963.8 - 892.8)

Volume	Invert	Avail.Storage	Storage Description
#1	143.00'	14,736 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
143.00	4,110	838.0	0	0	4,110
144.00	7,342	863.0	5,648	5,648	7,599
145.00	10,953	882.0	9,088	14,736	10,378

Device	Routing	Invert	Outlet Devices
#1	Primary	139.50'	**15.0" Round Culvert OUTLET** L= 115.0' Ke= 0.500 Inlet / Outlet Invert= 139.50' / 136.50' S= 0.0261 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	143.10'	**3.0" Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	143.40'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#4	Secondary	144.50'	**10.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.5 cfs @ 12.21 hrs HW=143.59' TW=111.54' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 4.5 cfs of 11.0 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.1 cfs @ 2.91 fps)
  └─**3=TOP OVERFLOW WEIR** (Weir Controls 4.3 cfs @ 1.42 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=143.00' TW=109.00' (Dynamic Tailwater)
└─**4=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS2: WQS2

Inflow Area =	53,367 sf,	0.00% Impervious,	Inflow Depth = 1.03"	for 10-Year event
Inflow =	0.5 cfs @	12.13 hrs, Volume=	4,582 cf	
Outflow =	0.3 cfs @	12.24 hrs, Volume=	4,511 cf,	Atten= 46%, Lag= 7.0 min
Primary =	0.3 cfs @	12.24 hrs, Volume=	4,511 cf	
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 143.68' @ 12.24 hrs Surf.Area= 1,061 sf Storage= 580 cf
Flood Elev= 143.10' Surf.Area= 712 sf Storage= 69 cf

Plug-Flow detention time= 128.4 min calculated for 4,508 cf (98% of inflow)
Center-of-Mass det. time= 122.7 min (1,146.8 - 1,024.1)

Volume	Invert	Avail.Storage	Storage Description
#1	143.00'	2,575 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
143.00	659	196.0	0	0	659
144.00	1,283	225.0	954	954	1,653
145.00	1,984	251.0	1,621	2,575	2,666

Device	Routing	Invert	Outlet Devices
#1	Primary	141.25'	**15.0" Round Culvert OUTLET** L= 35.1' Ke= 0.500 Inlet / Outlet Invert= 141.25' / 139.50' S= 0.0499 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	143.10'	**1.0" Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	143.65'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#4	Secondary	144.50'	**6.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.3 cfs @ 12.24 hrs HW=143.68' TW=111.57' (Dynamic Tailwater)
└1=**Culvert OUTLET** (Passes 0.3 cfs of 7.9 cfs potential flow)
 ├2=**LOW FLOW OUTLET** (Orifice Controls 0.0 cfs @ 3.53 fps)
 └3=**TOP OVERFLOW WEIR** (Weir Controls 0.3 cfs @ 0.56 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=143.00' TW=109.00' (Dynamic Tailwater)
└4=**EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS3: WQS3

Inflow Area =	81,404 sf,	0.49% Impervious,	Inflow Depth = 2.40"	for 10-Year event
Inflow =	5.0 cfs @	12.12 hrs, Volume=	16,255 cf	
Outflow =	1.3 cfs @	12.35 hrs, Volume=	16,119 cf,	Atten= 73%, Lag= 14.2 min
Primary =	1.3 cfs @	12.35 hrs, Volume=	16,119 cf	
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 182.53' @ 12.35 hrs Surf.Area= 3,919 sf Storage= 4,102 cf
Flood Elev= 181.10' Surf.Area= 1,420 sf Storage= 134 cf

Plug-Flow detention time= 48.7 min calculated for 16,119 cf (99% of inflow)
Center-of-Mass det. time= 43.4 min (901.7 - 858.3)

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	17,330 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
181.00	1,261	147.0	0	0	1,261
182.00	3,271	245.0	2,188	2,188	4,324
183.00	4,534	296.0	3,885	6,073	6,537
184.00	5,604	338.0	5,060	11,133	8,679
185.00	6,810	396.0	6,197	17,330	12,087

Device	Routing	Invert	Outlet Devices
#1	Primary	179.00'	**18.0" Round Culvert OUTLET** L= 89.1' Ke= 0.500 Inlet / Outlet Invert= 179.00' / 177.50' S= 0.0168 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	181.10'	**3.0" Vert. LOW FLOW OUTLET X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Device 1	181.90'	**3.0" Vert. MIDDLE ORIFICES X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	184.00'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#5	Secondary	184.50'	**10.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.3 cfs @ 12.35 hrs HW=182.53' TW=111.41' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 1.3 cfs of 14.2 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.8 cfs @ 5.51 fps)
  ├─**3=MIDDLE ORIFICES** (Orifice Controls 0.5 cfs @ 3.43 fps)
  └─**4=TOP OVERFLOW WEIR** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=181.00' TW=109.00' (Dynamic Tailwater)
└─**5=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS4: WQS4

Inflow Area = 107,110 sf, 0.00% Impervious, Inflow Depth = 2.22" for 10-Year event
Inflow = 4.7 cfs @ 12.18 hrs, Volume= 19,818 cf
Outflow = 3.2 cfs @ 12.31 hrs, Volume= 19,816 cf, Atten= 32%, Lag= 7.7 min
Primary = 3.2 cfs @ 12.31 hrs, Volume= 19,816 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 113.12' @ 12.31 hrs Surf.Area= 2,601 sf Storage= 2,375 cf
Flood Elev= 111.30' Surf.Area= 43 sf Storage= 2 cf

Plug-Flow detention time= 9.3 min calculated for 19,816 cf (100% of inflow)
Center-of-Mass det. time= 8.9 min (880.9 - 872.0)

Volume	Invert	Avail.Storage	Storage Description
#1	111.20'	6,843 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
111.20	10	5.0	0	0	10
111.50	179	88.0	23	23	624
112.00	1,102	222.0	288	311	3,931
113.00	2,495	276.0	1,752	2,062	6,085
114.00	3,426	314.0	2,948	5,011	7,894
114.50	3,908	328.0	1,832	6,843	8,627

Device	Routing	Invert	Outlet Devices
#1	Primary	109.60'	**12.0" Round Culvert OUTLET** L= 134.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.60' / 108.30' S= 0.0097 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	111.30'	**6.0" W x 3.0" H Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	112.05'	**8.0" W x 15.0" H Vert. MIDDLE WEIR** C= 0.600 Limited to weir flow at low heads
#4	Device 1	113.30'	**48.0" x 48.0" Horiz. TOP WEIR** C= 0.600 Limited to weir flow at low heads
#5	Secondary	114.00'	**10.0' long x 7.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.40 2.52 2.70 2.68 2.68 2.67 2.66 2.65 2.65 2.65 2.66 2.65 2.66 2.68 2.70 2.73 2.78

Primary OutFlow Max=3.1 cfs @ 12.31 hrs HW=113.12' TW=110.03' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 3.1 cfs of 4.5 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.8 cfs @ 6.26 fps)
  ├─**3=MIDDLE WEIR** (Orifice Controls 2.4 cfs @ 3.32 fps)
  └─**4=TOP WEIR** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=111.20' TW=108.00' (Dynamic Tailwater)
└─**5=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Link AP-2A: 36" RCP

Inflow Area = 777,113 sf, 1.45% Impervious, Inflow Depth = 1.46" for 10-Year event
Inflow = 15.8 cfs @ 12.25 hrs, Volume= 94,660 cf
Primary = 15.8 cfs @ 12.25 hrs, Volume= 94,660 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2B: 24" RCP

Inflow Area = 359,530 sf, 6.51% Impervious, Inflow Depth = 2.15" for 10-Year event
Inflow = 12.5 cfs @ 12.30 hrs, Volume= 64,353 cf
Primary = 12.5 cfs @ 12.30 hrs, Volume= 64,353 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP1: AP-1

Inflow Area =	142,959 sf,	0.65% Impervious, Inflow Depth = 2.24"	for 10-Year event
Inflow =	4.2 cfs @ 12.20 hrs, Volume=	26,704 cf	
Primary =	4.2 cfs @ 12.20 hrs, Volume=	26,704 cf, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP3: AP-3

Inflow Area =	19,815 sf,	0.00% Impervious, Inflow Depth = 1.99"	for 10-Year event
Inflow =	0.7 cfs @ 12.24 hrs, Volume=	3,284 cf	
Primary =	0.7 cfs @ 12.24 hrs, Volume=	3,284 cf, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P1: TO SD Runoff Area=16,143 sf 4.08% Impervious Runoff Depth=4.54"
Flow Length=204' Tc=8.3 min CN=64 Runoff=1.7 cfs 6,113 cf

Subcatchment P10: TO GS-B Runoff Area=21,159 sf 1.51% Impervious Runoff Depth=6.14"
Flow Length=45' Slope=0.0667 '/' Tc=5.0 min CN=77 Runoff=3.2 cfs 10,832 cf

Subcatchment P11: TO GS-C Runoff Area=144,531 sf 0.00% Impervious Runoff Depth=5.90"
Flow Length=67' Tc=5.0 min CN=75 Runoff=21.3 cfs 71,029 cf

Subcatchment P12: TO GS-D Runoff Area=25,460 sf 0.00% Impervious Runoff Depth=6.63"
Flow Length=75' Tc=5.0 min CN=81 Runoff=4.1 cfs 14,075 cf

Subcatchment P13: TO SWL1D Runoff Area=17,550 sf 1.82% Impervious Runoff Depth=6.88"
Flow Length=327' Tc=5.0 min CN=83 Runoff=2.9 cfs 10,060 cf

Subcatchment P14: TO WQS3 Runoff Area=81,404 sf 0.49% Impervious Runoff Depth=6.02"
Flow Length=385' Tc=5.0 min CN=76 Runoff=12.2 cfs 40,839 cf

Subcatchment P15: TO CB3 Runoff Area=31,226 sf 0.00% Impervious Runoff Depth=6.02"
Flow Length=550' Tc=13.4 min CN=76 Runoff=3.6 cfs 15,666 cf

Subcatchment P16: TO AP-3 Runoff Area=19,815 sf 0.00% Impervious Runoff Depth=5.41"
Flow Length=259' Tc=14.8 min CN=71 Runoff=2.0 cfs 8,925 cf

Subcatchment P17: TO GS-E Runoff Area=43,526 sf 0.00% Impervious Runoff Depth=5.77"
Flow Length=184' Tc=5.0 min CN=74 Runoff=6.3 cfs 20,944 cf

Subcatchment P18: TO SWL2 Runoff Area=3,212 sf 0.00% Impervious Runoff Depth=5.77"
Tc=5.0 min CN=74 Runoff=0.5 cfs 1,546 cf

Subcatchment P19: TO WQS2 Runoff Area=6,629 sf 0.00% Impervious Runoff Depth=5.77"
Flow Length=31' Slope=0.2260 '/' Tc=5.0 min CN=74 Runoff=1.0 cfs 3,190 cf

Subcatchment P2: TO WQS4 Runoff Area=75,884 sf 0.00% Impervious Runoff Depth=5.65"
Flow Length=285' Tc=9.3 min CN=73 Runoff=9.3 cfs 35,737 cf

Subcatchment P3: TO AP1 Runoff Area=19,706 sf 1.38% Impervious Runoff Depth=7.00"
Flow Length=498' Tc=6.6 min CN=84 Runoff=3.2 cfs 11,497 cf

Subcatchment P4: TO CB2 Runoff Area=66,052 sf 0.00% Impervious Runoff Depth=5.53"
Flow Length=824' Tc=16.4 min CN=72 Runoff=6.4 cfs 30,429 cf

Subcatchment P5A: TO EX.36" Runoff Area=273,835 sf 3.65% Impervious Runoff Depth=5.53"
Flow Length=691' Tc=16.5 min CN=72 Runoff=26.7 cfs 126,153 cf

Subcatchment P5B: TO EX.24" Runoff Area=359,530 sf 6.51% Impervious Runoff Depth=5.65"
Flow Length=783' Tc=19.6 min CN=73 Runoff=32.9 cfs 169,318 cf

Subcatchment P6: TO WQS1 Runoff Area=22,064 sf 0.00% Impervious Runoff Depth=5.77"
Flow Length=35' Slope=0.1700 '/' Tc=5.0 min CN=74 Runoff=3.2 cfs 10,617 cf

Subcatchment P7: TO GS-A Runoff Area=61,702 sf 0.00% Impervious Runoff Depth=5.77"
Flow Length=308' Tc=5.0 min CN=74 Runoff=8.9 cfs 29,691 cf

Subcatchment P8: TO CB1 Runoff Area=3,312 sf 0.00% Impervious Runoff Depth=5.77"
Flow Length=119' Slope=0.1180 '/' Tc=5.0 min CN=74 Runoff=0.5 cfs 1,594 cf

Subcatchment P9: TO HW#1 Runoff Area=6,677 sf 3.29% Impervious Runoff Depth=7.00"
Flow Length=267' Tc=5.0 min CN=84 Runoff=1.1 cfs 3,895 cf

Reach OF: TO WREP Avg. Flow Depth=0.13' Max Vel=1.70 fps Inflow=3.6 cfs 15,666 cf
n=0.035 L=180.0' S=0.0389 '/' Capacity=1,899.8 cfs Outflow=3.5 cfs 15,666 cf

Reach OF2: FROM WREP Avg. Flow Depth=0.54' Max Vel=4.03 fps Inflow=3.5 cfs 15,666 cf
n=0.035 L=126.0' S=0.0556 '/' Capacity=115.9 cfs Outflow=3.5 cfs 15,666 cf

Reach SWL1A: Avg. Flow Depth=0.41' Max Vel=6.78 fps Inflow=9.0 cfs 92,280 cf
n=0.035 L=157.0' S=0.1338 '/' Capacity=263.5 cfs Outflow=9.0 cfs 92,280 cf

Reach SWL1B: Avg. Flow Depth=0.36' Max Vel=7.75 fps Inflow=8.7 cfs 75,074 cf
n=0.035 L=20.0' S=0.2000 '/' Capacity=322.2 cfs Outflow=8.7 cfs 75,074 cf

Reach SWL1C: Avg. Flow Depth=0.39' Max Vel=4.89 fps Inflow=6.1 cfs 63,382 cf
n=0.035 L=301.0' S=0.0731 '/' Capacity=194.8 cfs Outflow=6.1 cfs 63,382 cf

Reach SWL1D: Avg. Flow Depth=0.35' Max Vel=5.84 fps Inflow=6.1 cfs 21,856 cf
n=0.035 L=25.0' S=0.1200 '/' Capacity=249.6 cfs Outflow=6.2 cfs 21,856 cf

Reach SWL2: Avg. Flow Depth=0.56' Max Vel=6.20 fps Inflow=6.0 cfs 17,158 cf
n=0.035 L=265.0' S=0.1245 '/' Capacity=173.6 cfs Outflow=5.9 cfs 17,158 cf

Pond 24"-RCP: EX. 24" CULV Peak Elev=101.54' Storage=150 cf Inflow=32.9 cfs 169,318 cf
36.0" Round Culvert n=0.011 L=81.0' S=0.0062 '/' Outflow=32.9 cfs 169,316 cf

Pond 36"-RCP: EX. 36" CULV Peak Elev=114.18' Storage=182 cf Inflow=45.6 cfs 319,976 cf
36.0" Round Culvert n=0.011 L=57.0' S=0.0135 '/' Outflow=45.7 cfs 319,974 cf

Pond CB1: Peak Elev=166.42' Inflow=0.5 cfs 1,594 cf
12.0" Round Culvert n=0.013 L=62.0' S=0.0081 '/' Outflow=0.5 cfs 1,594 cf

Pond CB2: Peak Elev=148.01' Storage=0 cf Inflow=6.4 cfs 30,429 cf
15.0" Round Culvert n=0.013 L=264.0' S=0.0049 '/' Outflow=6.4 cfs 30,430 cf

Pond CB3: Peak Elev=130.55' Inflow=3.6 cfs 15,666 cf
12.0" Round Culvert n=0.013 L=34.0' S=0.0118 '/' Outflow=3.6 cfs 15,666 cf

Pond CLV1: HW#1 Peak Elev=175.47' Storage=692 cf Inflow=7.1 cfs 67,278 cf
15.0" Round Culvert n=0.013 L=65.0' S=0.1231 '/' Outflow=6.3 cfs 67,278 cf

Pond GS-A: Grassed Swales Peak Elev=167.07' Storage=15,516 cf Inflow=8.9 cfs 29,691 cf
Outflow=1.2 cfs 15,612 cf

Pond GS-B: Grassed Swales Peak Elev=171.19' Storage=3,845 cf Inflow=3.2 cfs 10,832 cf
Outflow=2.5 cfs 7,796 cf

Pond GS-C: Grassed Swales Peak Elev=197.11' Storage=34,186 cf Inflow=21.3 cfs 71,029 cf
Outflow=4.1 cfs 41,526 cf

Pond GS-D: Grassed Swales Peak Elev=200.37' Storage=3,460 cf Inflow=4.1 cfs 14,075 cf
Outflow=3.5 cfs 11,796 cf

Pond GS-E: Grassed Swales Peak Elev=180.12' Storage=6,553 cf Inflow=6.3 cfs 20,944 cf
Outflow=5.6 cfs 15,612 cf

Pond SD: stone diaphragm Peak Elev=110.07' Storage=213 cf Inflow=10.8 cfs 57,513 cf
Outflow=10.8 cfs 57,306 cf

Pond WQS1: WQS1 Peak Elev=144.28' Storage=7,866 cf Inflow=16.8 cfs 133,326 cf
Primary=12.1 cfs 132,844 cf Secondary=0.0 cfs 0 cf Outflow=12.1 cfs 132,844 cf

Pond WQS2: WQS2 Peak Elev=143.90' Storage=835 cf Inflow=6.7 cfs 20,347 cf
Primary=6.7 cfs 20,276 cf Secondary=0.0 cfs 0 cf Outflow=6.7 cfs 20,276 cf

Pond WQS3: WQS3 Peak Elev=184.08' Storage=11,561 cf Inflow=12.2 cfs 40,839 cf
Primary=3.3 cfs 40,704 cf Secondary=0.0 cfs 0 cf Outflow=3.3 cfs 40,704 cf

Pond WQS4: WQS4 Peak Elev=114.33' Storage=6,177 cf Inflow=12.2 cfs 51,403 cf
Primary=5.3 cfs 48,705 cf Secondary=4.5 cfs 2,695 cf Outflow=9.8 cfs 51,400 cf

Link AP-2A: 36" RCP Inflow=45.7 cfs 319,974 cf
Primary=45.7 cfs 319,974 cf

Link AP-2B: 24" RCP Inflow=32.9 cfs 169,316 cf
Primary=32.9 cfs 169,316 cf

Link AP1: AP-1 Inflow=12.2 cfs 68,803 cf
Primary=12.2 cfs 68,803 cf

Link AP3: AP-3 Inflow=2.0 cfs 8,925 cf
Primary=2.0 cfs 8,925 cf

Summary for Subcatchment P1: TO SD

Runoff = 1.7 cfs @ 12.15 hrs, Volume= 6,113 cf, Depth= 4.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
370	98	Roofs, HSG A
288	98	Paved parking, HSG A
4,843	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG C
7,790	74	>75% Grass cover, Good, HSG C
2,852	70	Woods, Good, HSG C
0	96	Gravel surface, HSG A
16,143	64	Weighted Average
15,485		95.92% Pervious Area
658		4.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	75	0.1540	0.16		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.2	28	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	46	0.1540	6.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	55	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	204	Total			

Summary for Subcatchment P10: TO GS-B

Runoff = 3.2 cfs @ 12.11 hrs, Volume= 10,832 cf, Depth= 6.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
18,619	74	>75% Grass cover, Good, HSG C
2,220	96	Gravel surface, HSG C
320	98	Unconnected pavement, HSG C
21,159	77	Weighted Average
20,839		98.49% Pervious Area
320		1.51% Impervious Area
320		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	45	0.0667	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	45	Total			

Summary for Subcatchment P11: TO GS-C

Runoff = 21.3 cfs @ 12.11 hrs, Volume= 71,029 cf, Depth= 5.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
140,163	74	>75% Grass cover, Good, HSG C
3,993	96	Gravel surface, HSG C
375	70	Woods, Good, HSG C
144,531	75	Weighted Average
144,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0310	1.29		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
2.8	35	0.0570	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	67	Total			

Summary for Subcatchment P12: TO GS-D

Runoff = 4.1 cfs @ 12.11 hrs, Volume= 14,075 cf, Depth= 6.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
17,020	74	>75% Grass cover, Good, HSG C
7,895	96	Gravel surface, HSG C
442	70	Woods, Good, HSG C
103	74	>75% Grass cover, Good, HSG C
25,460	81	Weighted Average
25,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	28	0.0357	1.33		**Sheet Flow, grvl** Smooth surfaces n= 0.011 P2= 3.15"
3.2	31	0.0322	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.5	16	0.0050	0.54		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
1.0					**Direct Entry, 5.0 min.**
5.0	75	Total			

Summary for Subcatchment P13: TO SWL1D

Runoff = 2.9 cfs @ 12.11 hrs, Volume= 10,060 cf, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
10,471	74	>75% Grass cover, Good, HSG C
6,726	96	Gravel surface, HSG C
320	98	Unconnected pavement, HSG C
33	74	>75% Grass cover, Good, HSG C
17,550	83	Weighted Average
17,230		98.18% Pervious Area
320		1.82% Impervious Area
320		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	30	0.0630	1.70		**Sheet Flow, grvl** Smooth surfaces n= 0.011 P2= 3.15"
3.3	45	0.0630	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.0	12	0.0630	4.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	240	0.0750	4.41		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5					**Direct Entry, 5.0 min**
5.0	327	Total			

Summary for Subcatchment P14: TO WQS3

Runoff = 12.2 cfs @ 12.11 hrs, Volume= 40,839 cf, Depth= 6.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
7,914	96	Gravel surface, HSG C
70,819	74	>75% Grass cover, Good, HSG C
2,271	70	Woods, Good, HSG C
400	98	Unconnected pavement, HSG C
0	74	>75% Grass cover, Good, HSG C
81,404	76	Weighted Average
81,004		99.51% Pervious Area
400		0.49% Impervious Area
400		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	75	0.0200	1.29		**Sheet Flow, GRASS** Smooth surfaces n= 0.011 P2= 3.15"
1.3	175	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	135	0.1040	5.19		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.3					**Direct Entry, 5.0 MIN.**
5.0	385	Total			

Summary for Subcatchment P15: TO CB3

Runoff = 3.6 cfs @ 12.21 hrs, Volume= 15,666 cf, Depth= 6.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
12,202	74	>75% Grass cover, Good, HSG C
4,836	96	Gravel surface, HSG C
14,188	70	Woods, Good, HSG C
0	74	>75% Grass cover, Good, HSG C
31,226	76	Weighted Average
31,226		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	75	0.0680	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.1	87	0.0680	1.30		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	114	0.1500	6.24		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	81	0.1500	6.24		**Shallow Concentrated Flow, grvrl** Unpaved Kv= 16.1 fps
1.0	115	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	78	0.1030	5.17		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	550	Total			

Summary for Subcatchment P16: TO AP-3

Runoff = 2.0 cfs @ 12.23 hrs, Volume= 8,925 cf, Depth= 5.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
12,429	70	Woods, Good, HSG C
7,386	74	>75% Grass cover, Good, HSG C
19,815	71	Weighted Average
19,815		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	75	0.0440	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
1.7	106	0.0440	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	78	0.1790	2.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.8	259	Total			

Summary for Subcatchment P17: TO GS-E

Runoff = 6.3 cfs @ 12.11 hrs, Volume= 20,944 cf, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
43,526	74	>75% Grass cover, Good, HSG C
0	74	>75% Grass cover, Good, HSG C
43,526	74	Weighted Average
43,526		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	75	0.0800	2.24		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.3	49	0.0310	2.83		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.5	60	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.6					**Direct Entry, 5.0 MIN**
5.0	184	Total			

Summary for Subcatchment P18: TO SWL2

Runoff = 0.5 cfs @ 12.11 hrs, Volume= 1,546 cf, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
3,212	74	>75% Grass cover, Good, HSG C
3,212		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5.0 MIN**

Summary for Subcatchment P19: TO WQS2

Runoff = 1.0 cfs @ 12.11 hrs, Volume= 3,190 cf, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
6,629	74	>75% Grass cover, Good, HSG C
6,629		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	31	0.2260	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
3.5					**Direct Entry, MIN TC = 5.0 MIN**
5.0	31	Total			

Summary for Subcatchment P2: TO WQS4

Runoff = 9.3 cfs @ 12.16 hrs, Volume= 35,737 cf, Depth= 5.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
55,955	70	Woods, Good, HSG C
13,098	74	>75% Grass cover, Good, HSG C
6,831	96	Gravel surface, HSG C
75,884	73	Weighted Average
75,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	75	0.1660	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.4	55	0.1660	2.04		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.5	142	0.0950	1.54		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	13	0.3300	9.25		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.3	285	Total			

Summary for Subcatchment P3: TO AP1

Runoff = 3.2 cfs @ 12.14 hrs, Volume= 11,497 cf, Depth= 7.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
1,002	39	>75% Grass cover, Good, HSG A
4,040	96	Gravel surface, HSG A
6,422	96	Gravel surface, HSG C
5,625	74	>75% Grass cover, Good, HSG C
2,270	70	Woods, Good, HSG C
76	30	Woods, Good, HSG A
256	98	Unconnected pavement, HSG C
15	98	Roofs, HSG A
19,706	84	Weighted Average
19,435		98.62% Pervious Area
271		1.38% Impervious Area
256		94.46% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	75	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.0	12	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	53	0.0750	4.41		**Shallow Concentrated Flow, GRVL** Unpaved Kv= 16.1 fps
2.3	358	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	498	Total			

Summary for Subcatchment P4: TO CB2

Runoff = 6.4 cfs @ 12.25 hrs, Volume= 30,429 cf, Depth= 5.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
36,514	74	>75% Grass cover, Good, HSG C
29,013	70	Woods, Good, HSG C
525	96	Gravel surface, HSG C
66,052	72	Weighted Average
66,052		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	40	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.4	35	0.0350	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.3	290	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	90	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4	105	0.0670	1.29		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	211	0.1660	6.56		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	53	0.1510	6.26		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
16.4	824	Total			

Summary for Subcatchment P5A: TO EX.36"

Runoff = 26.7 cfs @ 12.25 hrs, Volume= 126,153 cf, Depth= 5.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
0	96	Gravel surface, HSG C
187,867	70	Woods, Good, HSG C
75,981	74	>75% Grass cover, Good, HSG C
9,587	98	Paved parking, HSG C
400	98	Unconnected pavement, HSG C
273,835	72	Weighted Average
263,848		96.35% Pervious Area
9,987		3.65% Impervious Area
400		4.01% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	27	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
8.4	48	0.0490	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.8	54	0.0490	1.11		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.6	130	0.0770	1.39		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.5	305	0.1640	2.02		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.1	127	0.0390	0.99		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.5	691	Total			

Summary for Subcatchment P5B: TO EX.24"

Runoff = 32.9 cfs @ 12.29 hrs, Volume= 169,318 cf, Depth= 5.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
5,494	96	Gravel surface, HSG C
277,852	70	Woods, Good, HSG C
52,653	74	>75% Grass cover, Good, HSG C
20,671	98	Paved parking, HSG C
2,721	98	Roofs, HSG C
139	74	>75% Grass cover, Good, HSG C
359,530	73	Weighted Average
336,138		93.49% Pervious Area
23,392		6.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	57	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.0	18	0.2500	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.3	52	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.9	209	0.0140	0.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.5	221	0.0180	0.67		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	117	0.0260	0.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.4	109	0.0700	1.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.6	783	Total			

Summary for Subcatchment P6: TO WQS1

Runoff = 3.2 cfs @ 12.11 hrs, Volume= 10,617 cf, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
21,626	74	>75% Grass cover, Good, HSG C
438	96	Gravel surface, HSG C
22,064	74	Weighted Average
22,064		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	35	0.1700	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
3.2					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	35	Total			

Summary for Subcatchment P7: TO GS-A

Runoff = 8.9 cfs @ 12.11 hrs, Volume= 29,691 cf, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
60,550	74	>75% Grass cover, Good, HSG C
1,152	96	Gravel surface, HSG C
0	98	Unconnected pavement, HSG C
61,702	74	Weighted Average
61,702		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	75	0.1050	2.50		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.1	39	0.1050	5.22		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.1	30	0.1000	5.09		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.3	86	0.0700	4.26		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.0	19	0.3330	9.29		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	59	0.1530	6.30		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.8					**Direct Entry, MIN TC = 5.0 MIN**
5.0	308	Total			

Summary for Subcatchment P8: TO CB1

Runoff = 0.5 cfs @ 12.11 hrs, Volume= 1,594 cf, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
3,312	74	>75% Grass cover, Good, HSG C
3,312		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	75	0.1180	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.1	44	0.1180	5.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	119	Total			

Summary for Subcatchment P9: TO HW#1

Runoff = 1.1 cfs @ 12.11 hrs, Volume= 3,895 cf, Depth= 7.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
3,729	74	>75% Grass cover, Good, HSG C
0	98	Unconnected pavement, HSG C
2,728	96	Gravel surface, HSG C
220	98	Unconnected pavement, HSG C
6,677	84	Weighted Average
6,457		96.71% Pervious Area
220		3.29% Impervious Area
220		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	75	0.0950	2.40		**Sheet Flow, GRVL DRV** Smooth surfaces n= 0.011 P2= 3.15"
0.2	61	0.0660	4.14		**Shallow Concentrated Flow, GRVL DRV** Unpaved Kv= 16.1 fps
0.1	28	0.1430	6.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	103	0.2040	7.27		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0					**Direct Entry, MIN. TC = 5.0 MIN**
5.0	267	Total			

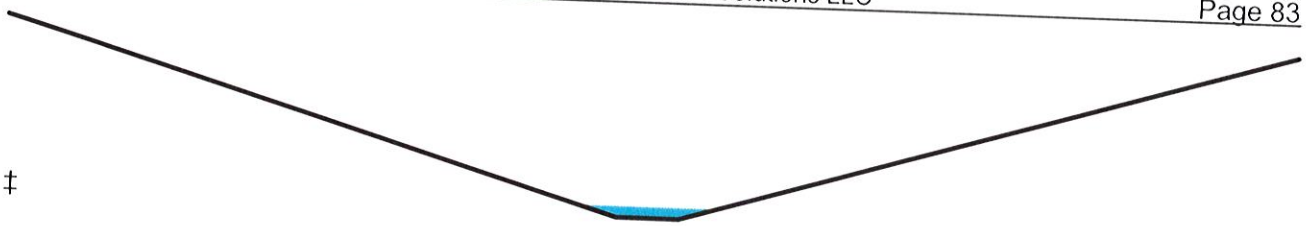
Summary for Reach OF: TO WREP

Inflow Area = 31,226 sf, 0.00% Impervious, Inflow Depth = 6.02" for 100-Year event
Inflow = 3.6 cfs @ 12.21 hrs, Volume= 15,666 cf
Outflow = 3.5 cfs @ 12.24 hrs, Volume= 15,666 cf, Atten= 2%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.70 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 4.5 min

Peak Storage= 371 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.13' , Surface Width= 22.62'
Bank-Full Depth= 2.00' Flow Area= 220.0 sf, Capacity= 1,899.8 cfs

10.00' x 2.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 50.0 '/' Top Width= 210.00'
Length= 180.0' Slope= 0.0389 '/'
Inlet Invert= 129.00', Outlet Invert= 122.00'



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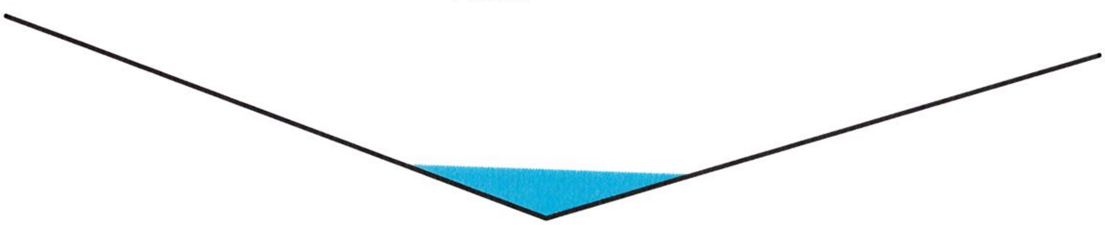
Summary for Reach OF2: FROM WREP

Inflow Area = 31,226 sf, 0.00% Impervious, Inflow Depth = 6.02" for 100-Year event
Inflow = 3.5 cfs @ 12.24 hrs, Volume= 15,666 cf
Outflow = 3.5 cfs @ 12.24 hrs, Volume= 15,666 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.03 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 1.2 min

Peak Storage= 110 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.54' , Surface Width= 3.23'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 115.9 cfs

0.00' x 2.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 126.0' Slope= 0.0556 '/'
Inlet Invert= 122.00', Outlet Invert= 115.00'



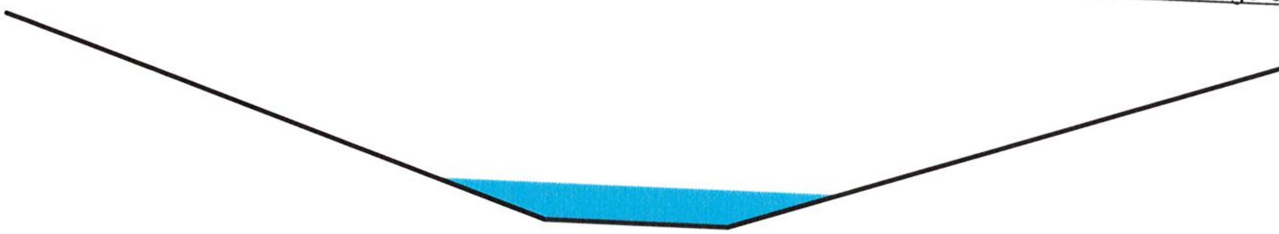
Summary for Reach SWL1A:

Inflow Area = 280,391 sf, 0.31% Impervious, Inflow Depth = 3.95" for 100-Year event
Inflow = 9.0 cfs @ 12.18 hrs, Volume= 92,280 cf
Outflow = 9.0 cfs @ 12.19 hrs, Volume= 92,280 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.78 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.05 fps, Avg. Travel Time= 1.3 min

Peak Storage= 208 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.41' , Surface Width= 4.46'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 263.5 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 157.0' Slope= 0.1338 '/'
Inlet Invert= 166.00', Outlet Invert= 145.00'



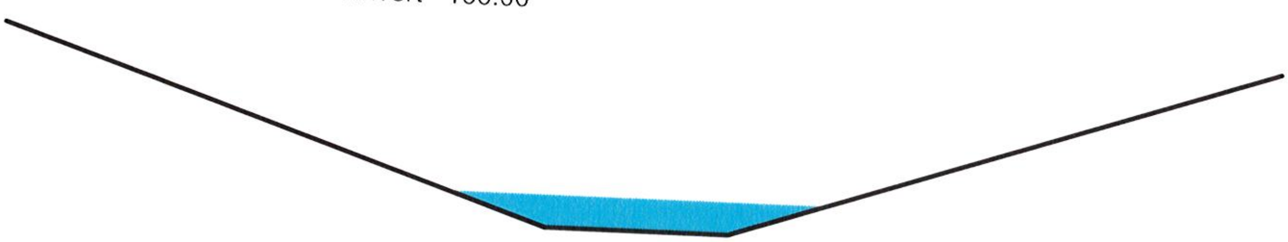
Summary for Reach SWL1B:

Inflow Area =	215,377 sf,	0.40% Impervious,	Inflow Depth = 4.18"	for 100-Year event
Inflow =	8.7 cfs @	12.19 hrs, Volume=	75,074 cf	
Outflow =	8.7 cfs @	12.19 hrs, Volume=	75,074 cf, Atten= 0%,	Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.75 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.35 fps, Avg. Travel Time= 0.1 min

Peak Storage= 22 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.36' , Surface Width= 4.18'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 322.2 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 20.0' Slope= 0.2000 '/'
Inlet Invert= 170.00', Outlet Invert= 166.00'



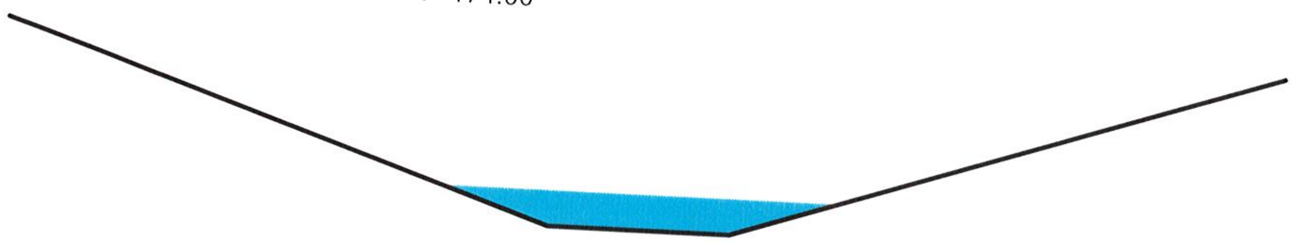
Summary for Reach SWL1C:

Inflow Area =	187,541 sf,	0.17% Impervious,	Inflow Depth = 4.06"	for 100-Year event
Inflow =	6.1 cfs @	12.15 hrs, Volume=	63,382 cf	
Outflow =	6.1 cfs @	12.16 hrs, Volume=	63,382 cf, Atten= 0%,	Lag= 0.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.89 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 3.4 min

Peak Storage= 377 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.39' , Surface Width= 4.36'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 194.8 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 301.0' Slope= 0.0731 '/'
Inlet Invert= 196.00', Outlet Invert= 174.00'



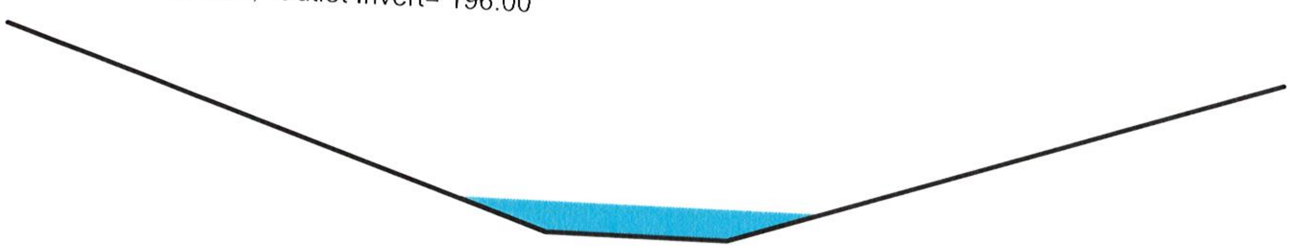
Summary for Reach SWL1D:

Inflow Area =	43,010 sf, 0.74% Impervious,	Inflow Depth = 6.10"	for 100-Year event
Inflow =	6.1 cfs @ 12.14 hrs, Volume=	21,856 cf	
Outflow =	6.2 cfs @ 12.14 hrs, Volume=	21,856 cf, Atten= 0%,	Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.84 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.66 fps, Avg. Travel Time= 0.3 min

Peak Storage= 26 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.35' , Surface Width= 4.08'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 249.6 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 25.0' Slope= 0.1200 '/'
Inlet Invert= 199.00', Outlet Invert= 196.00'



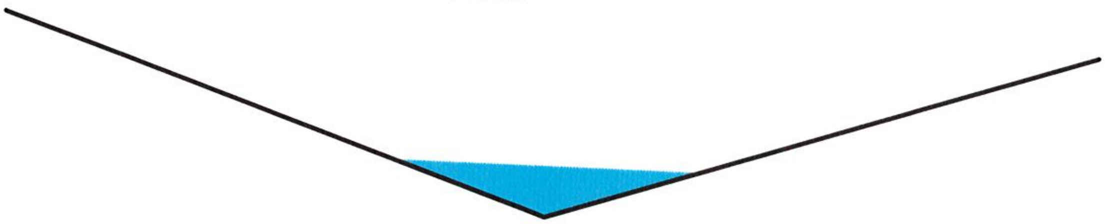
Summary for Reach SWL2:

Inflow Area =	46,738 sf, 0.00% Impervious,	Inflow Depth = 4.41"	for 100-Year event
Inflow =	6.0 cfs @ 12.15 hrs, Volume=	17,158 cf	
Outflow =	5.9 cfs @ 12.16 hrs, Volume=	17,158 cf, Atten= 1%,	Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.20 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 2.2 min

Peak Storage= 252 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.56' , Surface Width= 3.38'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 173.6 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 265.0' Slope= 0.1245 '/'
Inlet Invert= 178.00', Outlet Invert= 145.00'



Summary for Pond 24"-RCP: EX. 24" CULV

Inflow Area =	359,530 sf,	6.51% Impervious,	Inflow Depth = 5.65" for 100-Year event
Inflow =	32.9 cfs @	12.29 hrs, Volume=	169,318 cf
Outflow =	32.9 cfs @	12.29 hrs, Volume=	169,316 cf, Atten= 0%, Lag= 0.2 min
Primary =	32.9 cfs @	12.29 hrs, Volume=	169,316 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 101.54' @ 12.29 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= 0.8 min calculated for 169,316 cf (100% of inflow)
Center-of-Mass det. time= 0.1 min (845.9 - 845.9)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	4,909 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1	3.0	0	0	1
99.00	15	22.0	7	7	41
100.00	42	31.0	27	34	87
101.00	79	37.0	60	94	134
102.00	189	60.0	130	224	318
103.00	809	120.0	463	687	1,182
104.00	1,937	205.0	1,333	2,019	3,387
105.00	3,963	302.0	2,890	4,909	7,308

Device	Routing	Invert	Outlet Devices
#1	Primary	98.54'	**36.0" Round Culvert** L= 81.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 98.54' / 98.04' S= 0.0062 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=32.7 cfs @ 12.29 hrs HW=101.51' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 32.7 cfs @ 4.64 fps)

Summary for Pond 36"-RCP: EX. 36" CULV

```
Inflow Area =     777,113 sf,  1.45% Impervious,  Inflow Depth =  4.94"   for 100-Year event
Inflow      =      45.6 cfs @ 12.24 hrs, Volume=        319,976 cf
Outflow     =      45.7 cfs @ 12.24 hrs, Volume=        319,974 cf,  Atten= 0%,  Lag= 0.5 min
Primary     =      45.7 cfs @ 12.24 hrs, Volume=        319,974 cf
```

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 114.18' @ 12.24 hrs Surf.Area= 196 sf Storage= 182 cf

Plug-Flow detention time= 0.1 min calculated for 319,974 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (887.0 - 887.0)

Volume	Invert	Avail.Storage	Storage Description
#1	109.00'	412 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
109.00	1	4.0	0	0	1
110.00	4	9.0	2	2	9
111.00	10	15.0	7	9	26
112.00	18	19.0	14	23	46
113.00	43	27.0	30	53	83
114.00	165	52.0	97	150	245
115.00	372	74.0	262	412	475

Device	Routing	Invert	Outlet Devices
#1	Primary	109.79'	**36.0" Round Culvert** L= 57.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.79' / 109.02' S= 0.0135 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 7.07 sf

Primary OutFlow Max=45.5 cfs @ 12.24 hrs HW=114.16' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 45.5 cfs @ 6.44 fps)

Summary for Pond CB1:

```
Inflow Area =       3,312 sf,  0.00% Impervious,  Inflow Depth =  5.77"   for 100-Year event
Inflow      =       0.5 cfs @ 12.11 hrs, Volume=          1,594 cf
Outflow     =       0.5 cfs @ 12.11 hrs, Volume=          1,594 cf,  Atten= 0%,  Lag= 0.0 min
Primary     =       0.5 cfs @ 12.11 hrs, Volume=          1,594 cf
```

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.42' @ 12.23 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	164.00'	**12.0" Round Culvert** L= 62.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 164.00' / 163.50' S= 0.0081 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.0 cfs @ 12.11 hrs HW=166.33' TW=166.37' (Dynamic Tailwater)
└─**1=Culvert** (Controls 0.0 cfs)

Summary for Pond CB2:

Inflow Area =	66,052 sf,	0.00% Impervious,	Inflow Depth = 5.53"	for 100-Year event
Inflow =	6.4 cfs @	12.25 hrs, Volume=	30,429 cf	
Outflow =	6.4 cfs @	12.25 hrs, Volume=	30,430 cf,	Atten= 0%, Lag= 0.0 min
Primary =	6.4 cfs @	12.25 hrs, Volume=	30,430 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 148.01' @ 12.25 hrs Surf.Area= 3 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (845.6 - 845.6)

Volume	Invert	Avail.Storage	Storage Description
#1	148.00'	119 cf	**Custom Stage Data (Irregular)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
148.00	3	6.0	0	0	3
149.00	50	25.0	22	22	52
150.00	154	44.0	97	119	162

Device	Routing	Invert	Outlet Devices
#1	Primary	144.30'	**15.0" Round Culvert** L= 264.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 144.30' / 143.00' S= 0.0049 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=6.7 cfs @ 12.25 hrs HW=148.00' TW=144.10' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 6.7 cfs @ 5.48 fps)

Summary for Pond CB3:

Inflow Area =	31,226 sf,	0.00% Impervious,	Inflow Depth = 6.02"	for 100-Year event
Inflow =	3.6 cfs @	12.21 hrs, Volume=	15,666 cf	
Outflow =	3.6 cfs @	12.21 hrs, Volume=	15,666 cf,	Atten= 0%, Lag= 0.0 min
Primary =	3.6 cfs @	12.21 hrs, Volume=	15,666 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 130.55' @ 12.21 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	128.50'	**12.0" Round Culvert** L= 34.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 128.50' / 128.10' S= 0.0118 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.5 cfs @ 12.21 hrs HW=130.51' TW=129.12' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 3.5 cfs @ 4.47 fps)

Summary for Pond CLV1: HW#1

Inflow Area =	194,218 sf,	0.28% Impervious, Inflow Depth = 4.16"	for 100-Year event
Inflow =	7.1 cfs @	12.15 hrs, Volume=	67,278 cf
Outflow =	6.3 cfs @	12.35 hrs, Volume=	67,278 cf, Atten= 11%, Lag= 11.9 min
Primary =	6.3 cfs @	12.35 hrs, Volume=	67,278 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 175.47' @ 12.35 hrs Surf.Area= 583 sf Storage= 692 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.4 min (918.1 - 917.7)

Volume	Invert	Avail.Storage	Storage Description
#1	174.00'	1,585 cf	**Custom Stage Data (Irregular)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
174.00	274	91.0	0	0	274
175.00	583	126.0	419	419	888
176.00	583	126.0	583	1,002	1,014
177.00	583	126.0	583	1,585	1,140

Device	Routing	Invert	Outlet Devices
#1	Primary	173.00'	**15.0" Round Culvert** L= 65.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 173.00' / 165.00' S= 0.1231 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=6.3 cfs @ 12.35 hrs HW=175.47' TW=170.34' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 6.3 cfs @ 5.16 fps)

Summary for Pond GS-A: Grassed Swales

Inflow Area =	61,702 sf,	0.00% Impervious, Inflow Depth = 5.77"	for 100-Year event
Inflow =	8.9 cfs @	12.11 hrs, Volume=	29,691 cf
Outflow =	1.2 cfs @	12.73 hrs, Volume=	15,612 cf, Atten= 87%, Lag= 37.1 min
Primary =	1.2 cfs @	12.73 hrs, Volume=	15,612 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 167.07' @ 12.73 hrs Surf.Area= 18,112 sf Storage= 15,516 cf

Plug-Flow detention time= 302.7 min calculated for 15,601 cf (53% of inflow)
Center-of-Mass det. time= 162.5 min (992.2 - 829.7)

Volume	Invert	Avail.Storage	Storage Description
#1	165.50'	24,032 cf	**Custom Stage Data (Conic)**Listed below x 4

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
165.50	434	0	0	434
166.00	1,736	506	506	1,737
166.50	3,038	1,178	1,685	3,042
167.00	4,340	1,835	3,520	4,348
167.50	5,642	2,488	6,008	5,656

Device	Routing	Invert	Outlet Devices
#1	Primary	167.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 4.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=1.2 cfs @ 12.73 hrs HW=167.07' TW=166.35' (Dynamic Tailwater)
└─1=**Broad-Crested Rectangular Weir** (Weir Controls 1.2 cfs @ 0.68 fps)

Summary for Pond GS-B: Grassed Swales

Inflow Area = 21,159 sf, 1.51% Impervious, Inflow Depth = 6.14" for 100-Year event
Inflow = 3.2 cfs @ 12.11 hrs, Volume= 10,832 cf
Outflow = 2.5 cfs @ 12.17 hrs, Volume= 7,796 cf, Atten= 21%, Lag= 3.4 min
Primary = 2.5 cfs @ 12.17 hrs, Volume= 7,796 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 171.19' @ 12.17 hrs Surf.Area= 4,102 sf Storage= 3,845 cf

Plug-Flow detention time= 194.2 min calculated for 7,796 cf (72% of inflow)
Center-of-Mass det. time= 83.0 min (904.4 - 821.4)

Volume	Invert	Avail.Storage	Storage Description
#1	169.50'	5,152 cf	**Custom Stage Data (Prismatic)**Listed below x 2

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
169.50	184	0	0
170.00	736	230	230
170.50	1,288	506	736
171.00	1,840	782	1,518
171.50	2,392	1,058	2,576

Device	Routing	Invert	Outlet Devices
#1	Primary	171.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 2.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88

2.85 3.07 3.20 3.32

Primary OutFlow Max=2.4 cfs @ 12.17 hrs HW=171.19' TW=170.36' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 2.4 cfs @ 1.09 fps)

Summary for Pond GS-C: Grassed Swales

Inflow Area =	144,531 sf, 0.00% Impervious,	Inflow Depth = 5.90"	for 100-Year event
Inflow =	21.3 cfs @ 12.11 hrs, Volume=	71,029 cf	
Outflow =	4.1 cfs @ 12.47 hrs, Volume=	41,526 cf,	Atten= 81%, Lag= 21.1 min
Primary =	4.1 cfs @ 12.47 hrs, Volume=	41,526 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 197.11' @ 12.47 hrs Surf.Area= 38,204 sf Storage= 34,186 cf

Plug-Flow detention time= 272.8 min calculated for 41,497 cf (58% of inflow)
Center-of-Mass det. time= 140.1 min (967.0 - 826.9)

Volume	Invert	Avail.Storage	Storage Description
#1	195.50'	50,064 cf	**Custom Stage Data (Prismatic)** Listed below x 8

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
195.50	447	0	0
196.00	1,788	559	559
196.50	3,129	1,229	1,788
197.00	4,470	1,900	3,688
197.50	5,811	2,570	6,258

Device	Routing	Invert	Outlet Devices
#1	Primary	197.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 7.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=4.1 cfs @ 12.47 hrs HW=197.11' TW=196.38' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 4.1 cfs @ 0.86 fps)

Summary for Pond GS-D: Grassed Swales

Inflow Area =	25,460 sf, 0.00% Impervious,	Inflow Depth = 6.63"	for 100-Year event
Inflow =	4.1 cfs @ 12.11 hrs, Volume=	14,075 cf	
Outflow =	3.5 cfs @ 12.16 hrs, Volume=	11,796 cf,	Atten= 16%, Lag= 2.8 min
Primary =	3.5 cfs @ 12.16 hrs, Volume=	11,796 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 200.37' @ 12.16 hrs Surf.Area= 3,428 sf Storage= 3,460 cf

Plug-Flow detention time= 140.1 min calculated for 11,796 cf (84% of inflow)

Center-of-Mass det. time= 61.0 min (870.9 - 809.8)

Volume	Invert	Avail.Storage	Storage Description
#1	198.50'	3,890 cf	**Custom Stage Data (Conic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
198.50	281	0	0	281
199.00	1,124	328	328	1,125
199.50	1,967	763	1,091	1,971
200.00	2,810	1,188	2,279	2,818
200.50	3,653	1,611	3,890	3,667

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=3.4 cfs @ 12.16 hrs HW=200.36' TW=199.34' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 3.4 cfs @ 1.56 fps)

Summary for Pond GS-E: Grassed Swales

Inflow Area = 43,526 sf, 0.00% Impervious, Inflow Depth = 5.77" for 100-Year event
Inflow = 6.3 cfs @ 12.11 hrs, Volume= 20,944 cf
Outflow = 5.6 cfs @ 12.16 hrs, Volume= 15,612 cf, Atten= 12%, Lag= 2.5 min
Primary = 5.6 cfs @ 12.16 hrs, Volume= 15,612 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 180.12' @ 12.16 hrs Surf.Area= 9,367 sf Storage= 6,553 cf

Plug-Flow detention time= 177.1 min calculated for 15,612 cf (75% of inflow)
Center-of-Mass det. time= 71.4 min (901.1 - 829.7)

Volume	Invert	Avail.Storage	Storage Description
#1	178.50'	10,496 cf	**Custom Stage Data (Prismatic)**Listed below x 9

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
178.50	75	0	0
179.00	135	53	53
179.50	540	169	221
180.00	945	371	593
180.50	1,350	574	1,166

Device	Routing	Invert	Outlet Devices
#1	Primary	180.00'	**6.0' long x 2.0' breadth Broad-Crested Rectangular Weir X 9.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

2.50 3.00 3.50
Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88
2.85 3.07 3.20 3.32

Primary OutFlow Max=5.5 cfs @ 12.16 hrs HW=180.12' TW=178.56' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 5.5 cfs @ 0.87 fps)

Summary for Pond SD: stone diaphragm

Inflow Area =	123,253 sf,	0.53% Impervious,	Inflow Depth = 5.60"	for 100-Year event
Inflow =	10.8 cfs @	12.26 hrs, Volume=	57,513 cf	
Outflow =	10.8 cfs @	12.26 hrs, Volume=	57,306 cf,	Atten= 0%, Lag= 0.0 min
Primary =	10.8 cfs @	12.26 hrs, Volume=	57,306 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 110.07' @ 12.26 hrs Surf.Area= 200 sf Storage= 213 cf
Flood Elev= 110.50' Surf.Area= 200 sf Storage= 247 cf

Plug-Flow detention time= 4.2 min calculated for 57,306 cf (100% of inflow)
Center-of-Mass det. time= 1.8 min (850.9 - 849.1)

Volume	Invert	Avail.Storage	Storage Description
#1	108.00'	169 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 500 cf Overall - 79 cf Embedded = 421 cf x 40.0% Voids
#2	108.30'	79 cf	**12.0" Round Pipe Storage** Inside #1 L= 100.0'
		247 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
108.00	200	0	0
110.50	200	500	500

Device	Routing	Invert	Outlet Devices
#1	Primary	110.00'	**195.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=10.5 cfs @ 12.26 hrs HW=110.07' TW=0.00' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 10.5 cfs @ 0.73 fps)

Summary for Pond WQS1: WQS1

Inflow Area =	368,507 sf,	0.23% Impervious,	Inflow Depth = 4.34"	for 100-Year event
Inflow =	16.8 cfs @	12.19 hrs, Volume=	133,326 cf	
Outflow =	12.1 cfs @	12.45 hrs, Volume=	132,844 cf,	Atten= 28%, Lag= 16.0 min
Primary =	12.1 cfs @	12.45 hrs, Volume=	132,844 cf	
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 144.28' @ 12.45 hrs Surf.Area= 8,294 sf Storage= 7,866 cf
Flood Elev= 143.10' Surf.Area= 4,391 sf Storage= 425 cf

Plug-Flow detention time= 23.5 min calculated for 132,751 cf (100% of inflow)
Center-of-Mass det. time= 22.1 min (923.9 - 901.8)

Volume	Invert	Avail.Storage	Storage Description
#1	143.00'	14,736 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
143.00	4,110	838.0	0	0	4,110
144.00	7,342	863.0	5,648	5,648	7,599
145.00	10,953	882.0	9,088	14,736	10,378

Device	Routing	Invert	Outlet Devices
#1	Primary	139.50'	**15.0" Round Culvert OUTLET** L= 115.0' Ke= 0.500 Inlet / Outlet Invert= 139.50' / 136.50' S= 0.0261 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	143.10'	**3.0" Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	143.40'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#4	Secondary	144.50'	**10.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=12.0 cfs @ 12.45 hrs HW=144.28' TW=112.63' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Inlet Controls 12.0 cfs @ 9.82 fps)
  ├─**2=LOW FLOW OUTLET** (Passes < 0.2 cfs potential flow)
  └─**3=TOP OVERFLOW WEIR** (Passes < 43.4 cfs potential flow)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=143.00' TW=109.00' (Dynamic Tailwater)
└─**4=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS2: WQS2

Inflow Area =	53,367 sf,	0.00% Impervious,	Inflow Depth = 4.58"	for 100-Year event
Inflow =	6.7 cfs @	12.16 hrs, Volume=	20,347 cf	
Outflow =	6.7 cfs @	12.16 hrs, Volume=	20,276 cf,	Atten= 0%, Lag= 0.5 min
Primary =	6.7 cfs @	12.16 hrs, Volume=	20,276 cf	
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 143.90' @ 12.16 hrs Surf.Area= 1,215 sf Storage= 835 cf
Flood Elev= 143.10' Surf.Area= 712 sf Storage= 69 cf

Plug-Flow detention time= 33.3 min calculated for 20,276 cf (100% of inflow)
Center-of-Mass det. time= 30.9 min (916.4 - 885.6)

Volume	Invert	Avail.Storage	Storage Description
#1	143.00'	2,575 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
143.00	659	196.0	0	0	659
144.00	1,283	225.0	954	954	1,653
145.00	1,984	251.0	1,621	2,575	2,666

Device	Routing	Invert	Outlet Devices
#1	Primary	141.25'	**15.0" Round Culvert OUTLET** L= 35.1' Ke= 0.500 Inlet / Outlet Invert= 141.25' / 139.50' S= 0.0499 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	143.10'	**1.0" Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	143.65'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#4	Secondary	144.50'	**6.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=6.5 cfs @ 12.16 hrs HW=143.90' TW=113.69' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 6.5 cfs of 8.4 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 0.0 cfs @ 4.19 fps)
  └─**3=TOP OVERFLOW WEIR** (Weir Controls 6.5 cfs @ 1.63 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=143.00' TW=109.00' (Dynamic Tailwater)
└─**4=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS3: WQS3

Inflow Area =	81,404 sf,	0.49% Impervious,	Inflow Depth = 6.02"	for 100-Year event
Inflow =	12.2 cfs @	12.11 hrs, Volume=	40,839 cf	
Outflow =	3.3 cfs @	12.34 hrs, Volume=	40,704 cf,	Atten= 73%, Lag= 13.4 min
Primary =	3.3 cfs @	12.34 hrs, Volume=	40,704 cf	
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 184.08' @ 12.34 hrs Surf.Area= 5,691 sf Storage= 11,561 cf
Flood Elev= 181.10' Surf.Area= 1,420 sf Storage= 134 cf

Plug-Flow detention time= 57.2 min calculated for 40,675 cf (100% of inflow)
Center-of-Mass det. time= 55.5 min (879.6 - 824.2)

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	17,330 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
181.00	1,261	147.0	0	0	1,261
182.00	3,271	245.0	2,188	2,188	4,324
183.00	4,534	296.0	3,885	6,073	6,537
184.00	5,604	338.0	5,060	11,133	8,679
185.00	6,810	396.0	6,197	17,330	12,087

Device	Routing	Invert	Outlet Devices
#1	Primary	179.00'	**18.0" Round Culvert OUTLET** L= 89.1' Ke= 0.500 Inlet / Outlet Invert= 179.00' / 177.50' S= 0.0168 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	181.10'	**3.0" Vert. LOW FLOW OUTLET X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Device 1	181.90'	**3.0" Vert. MIDDLE ORIFICES X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	184.00'	**48.0" x 48.0" Horiz. TOP OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads
#5	Secondary	184.50'	**10.0' long x 10.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=3.3 cfs @ 12.34 hrs HW=184.07' TW=113.60' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Passes 3.3 cfs of 17.7 cfs potential flow)
  ├─**2=LOW FLOW OUTLET** (Orifice Controls 1.2 cfs @ 8.13 fps)
  ├─**3=MIDDLE ORIFICES** (Orifice Controls 1.0 cfs @ 6.89 fps)
  └─**4=TOP OVERFLOW WEIR** (Weir Controls 1.1 cfs @ 0.89 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=181.00' TW=109.00' (Dynamic Tailwater)
└─**5=EMERGENCY SPILLWAY** (Controls 0.0 cfs)

Summary for Pond WQS4: WQS4

Inflow Area = 107,110 sf, 0.00% Impervious, Inflow Depth = 5.76" for 100-Year event
Inflow = 12.2 cfs @ 12.18 hrs, Volume= 51,403 cf
Outflow = 9.8 cfs @ 12.27 hrs, Volume= 51,400 cf, Atten= 20%, Lag= 5.5 min
Primary = 5.3 cfs @ 12.27 hrs, Volume= 48,705 cf
Secondary = 4.5 cfs @ 12.27 hrs, Volume= 2,695 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 114.33' @ 12.27 hrs Surf.Area= 3,736 sf Storage= 6,177 cf
Flood Elev= 111.30' Surf.Area= 43 sf Storage= 2 cf

Plug-Flow detention time= 12.0 min calculated for 51,400 cf (100% of inflow)
Center-of-Mass det. time= 11.6 min (848.0 - 836.3)

Volume	Invert	Avail.Storage	Storage Description
#1	111.20'	6,843 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
111.20	10	5.0	0	0	10
111.50	179	88.0	23	23	624
112.00	1,102	222.0	288	311	3,931
113.00	2,495	276.0	1,752	2,062	6,085
114.00	3,426	314.0	2,948	5,011	7,894
114.50	3,908	328.0	1,832	6,843	8,627

Device	Routing	Invert	Outlet Devices
#1	Primary	109.60'	**12.0" Round Culvert OUTLET** L= 134.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 109.60' / 108.30' S= 0.0097 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	111.30'	**6.0" W x 3.0" H Vert. LOW FLOW OUTLET** C= 0.600 Limited to weir flow at low heads
#3	Device 1	112.05'	**8.0" W x 15.0" H Vert. MIDDLE WEIR** C= 0.600 Limited to weir flow at low heads
#4	Device 1	113.30'	**48.0" x 48.0" Horiz. TOP WEIR** C= 0.600 Limited to weir flow at low heads
#5	Secondary	114.00'	**10.0' long x 7.0' breadth EMERGENCY SPILLWAY** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.40 2.52 2.70 2.68 2.68 2.67 2.66 2.65 2.65 2.65 2.66 2.65 2.66 2.68 2.70 2.73 2.78

Primary OutFlow Max=5.2 cfs @ 12.27 hrs HW=114.31' TW=110.07' (Dynamic Tailwater)
└─**1=Culvert OUTLET** (Outlet Controls 5.2 cfs @ 6.68 fps)
  ├─**2=LOW FLOW OUTLET** (Passes < 1.0 cfs potential flow)
  ├─**3=MIDDLE WEIR** (Passes < 5.1 cfs potential flow)
  └─**4=TOP WEIR** (Passes < 53.0 cfs potential flow)

Secondary OutFlow Max=4.2 cfs @ 12.27 hrs HW=114.31' TW=110.07' (Dynamic Tailwater)
└─**5=EMERGENCY SPILLWAY** (Weir Controls 4.2 cfs @ 1.37 fps)

Summary for Link AP-2A: 36" RCP

Inflow Area = 777,113 sf, 1.45% Impervious, Inflow Depth = 4.94" for 100-Year event
Inflow = 45.7 cfs @ 12.24 hrs, Volume= 319,974 cf
Primary = 45.7 cfs @ 12.24 hrs, Volume= 319,974 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP-2B: 24" RCP

Inflow Area = 359,530 sf, 6.51% Impervious, Inflow Depth = 5.65" for 100-Year event
Inflow = 32.9 cfs @ 12.29 hrs, Volume= 169,316 cf
Primary = 32.9 cfs @ 12.29 hrs, Volume= 169,316 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP1: AP-1

Inflow Area =	142,959 sf,	0.65% Impervious,	Inflow Depth = 5.78"	for 100-Year event
Inflow =	12.2 cfs @	12.26 hrs, Volume=	68,803 cf	
Primary =	12.2 cfs @	12.26 hrs, Volume=	68,803 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link AP3: AP-3

Inflow Area =	19,815 sf,	0.00% Impervious,	Inflow Depth = 5.41"	for 100-Year event
Inflow =	2.0 cfs @	12.23 hrs, Volume=	8,925 cf	
Primary =	2.0 cfs @	12.23 hrs, Volume=	8,925 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Pre-Development Conditions

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

		Area (sf)	Area (Ac)
Total Subcatchment Areas		1,299,417	29.8
Total Subcatchment Areas On-Site		1,013,784	23.3
Total Area of Hydrolic Soil Groups On-Site		1,013,784	23.3
	A	5,320	0.1
	B	0	0.0
	C	1,008,464	23.2
	D	0	0.0
Surface Type Areas			
Pavement		30,546	0.7
	A	288	0.0
	C	30,258	0.7
Roofs		3,106	0.1
	A	385	0.0
	C	2,721	0.1
Gravel		4,836	0.1
	A	0	0.0
	C	4,836	0.1
Grass Cover		59,820	1.4
	A	9,812	0.2
	C	50,008	1.1
Woods		1,201,109	27.6
	A	149	0.0
	C	1,200,960	27.6
Total Impervious Area		33,652	0.8

Infiltration Volume

Inches of Recharge per Storm Event		
	A	0.60
	B	0.35
	C	0.25
	D	0.10

Infiltration Volume = ∑ {[(Total Subcatchment Area within HSG) - (Total Impervious Area within HSG)] x (inches of Recharge Per Storm)}

Infiltration Volume **20,555 CF**

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Post Development Conditions

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

		Area (sf)	Area (Ac)
Total Subcatchment Areas		1,299,417	29.8
Total Subcatchment Areas On-Site		1,013,784	23.3
Total Area of Hydrolic Soil Groups On-Site		1,013,784	23.3
	A	5,320	0.1
	B	0	0.0
	C	1,008,464	23.2
	D	0	0.0
Surface Type Areas			
Grass Cover		617,045	14.2
	A	5,845	0.1
	C	611,200	14.0
Gravel		61,214	1.4
	A	4,040	0.1
	C	57,174	1.3
Pavement		30,546	0.7
	A	288	0.0
	C	30,258	0.7
Roofs		3,106	0.1
	A	385	0.0
	C	2,721	0.1
Unconnected Pavement		1,916	0.0
	A	0	0.0
	C	1,916	0.0
Woods		585,590	13.4
	A	76	0.0
	C	585,514	13.4
Total Impervious Area		35,568	0.8

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Post Development Conditions

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Infiltration Volume

Inches of Recharge per Storm Event	A	0.60
	B	0.35
	C	0.25
	D	0.10

Infiltration Volume = ∑ {[(Total Subcatchment Area within HSG) - (Total Impervious Area within HSG)] x (inches of Recharge Per Storm)}

Natural Infiltration Volume	20,684	CF
Pre-Development Infiltration Volume	20,555	CF
Required Iniltration Volume	**-129**	**CF**

Provided Infiltration Volume

WQS1	425	CF	Volume below 143.10' Orifice
WQS2	69	CF	Volume below 143.10' Orifice
WQS3	134	CF	Volume below 181.10' Orifice
WQS4	2	CF	Volume below 111.30' Orifice

Total Provided Iniltration Volume	**630**	**CF**

Stormwater Management Standard 4
WATER QUALITY RETENTION VOLUME

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Parameter	Unit	Quantity	Remarks
Watershed area	sf	1,013,784	
Predevelopment impervious area	sf	33,652	
Total impervious area added	sf	1,916	
Total impervious area	sf	35,568	
Total impervious area required for retention	sf	1,916	
Runoff depth over impervious area	IN	1.0	
Required Water Quality Volume	**CF**	**160**	

Provided Water Quality Volume

WQS1	425	CF	Volume below 143.10' Orifice
WQS2	69	CF	Volume below 143.10' Orifice
WQS3	134	CF	Volume below 181.10' Orifice
WQS4	2	CF	Volume below 111.30' Orifice

DESIGN VOLUME PROVIDED	**CF**	**630**

Stormwater Management Standard 4
TSS REMOVAL

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Process Train No.	Impervious Area (SF)	BMP Type	TSS Removal Rate	TSS Remaining at Discharge	TSS Removed at Discharge
P6, P7, P10, P11, P12, P13*	880	Grass Swale	50%	50%	50%
		(Dry) WQS1	70%	30%	**85%**
P19*	0	(Dry) WQS2	70%	30%	**100%**
P14, P15*	0	(Dry) WQS3	70%	30%	**100%**
P2*	0	(Wet) WQS4	70%	30%	**100%**

* - Impervious areas within Subcatchments P2,P6,P7,P10,P11,P12,P13,P14,P15 and P19 are limited to proposed unconnected concrete pad that will not produce sediment. Any runoff produced by these areas must flow through long stretches of existing grass and water quality swales prior to reaching a design analysis point and have been considered as clean runoff for the above calculations.

ABBREVIATIONS:
TSS=total suspended solids; SF=square feet; SC=subcatchment; GC=grassed channel; BMP=best management practices; CB=deep CB=deep sump hooded catch basin; FB = Sediment Forebay; INF=infiltration basin; WB=wet basin; SP=Silt Prison Catch Basin

Stormwater Management Standard 4
TSS REMOVAL

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Process Train No.	Impervious Area (SF)	BMP Type	TSS Removal Rate	TSS Remaining at Discharge	TSS Removed at Discharge
P6, P7, P10, P11, P12, P13*	880	Sediment Forebay WQS1	50% 70%	50% 30%	**50%**
P19*	0	WQS2	70%	30%	**100%**
P14, P15*	0	WQS3	70%	30%	**100%**
P2*	0	WQS4	70%	30%	**100%**

Total Development Weighted Average **50%**

* - Impervious areas within Subcatchments P2,P6,P7,P10,P11,P12,P13,P14,P15 and P19 are limited to proposed unconnected concrete pad that will not produce sediment. Any runoff produced by these areas must flow through long stretches of existing grass and water quality swales prior to reaching a design analysis point and have been considered as clean runoff for the above calculations.

ABBREVIATIONS:
TSS=total suspended solids; SF=square feet; SC=subcatchment; GC=grassed channel; BMP=best management practices; CB=deep CB=deep sump hooded catch basin; FB = Sediment Forebay; INF=infiltration basin; WB=wet basin; SP=Silt Prison Catch Basin

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Infiltration Area Requirements

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Drawdown Time

(Per Massachusetts Stormwater regulations, infiltration areas must completely drain within 72 hours)

		WQS1
Infiltration Area Storage Volume	cf	425
Design infiltration Rate	in/hr	0.27
Infiltration Bottom Area	sf	4,110

Drawdown Time = Infiltration Area Storage Volume / [Design Infiltration Rate x Infiltration Area Bottom Area]

Drawdown Time (Hrs)	**4.6**

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Infiltration Area Requirements

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Drawdown Time

(Per Massachusetts Stormwater regulations, infiltration areas must completely drain within 72 hours)

		WQS2
Infiltration Area Storage Volume	cf	69
Design infiltration Rate	in/hr	0.27
Infiltration Bottom Area	sf	659

Drawdown Time = Infiltration Area Storage Volume / [Design Infiltration Rate x Infiltration Area Bottom Area]

Drawdown Time (Hrs)	**4.7**

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Infiltration Area Requirements

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Drawdown Time

(Per Massachusetts Stormwater regulations, infiltration areas must completely drain within 72 hours)

		WQS3
Infiltration Area Storage Volume	cf	134
Design infiltration Rate	in/hr	0.27
Infiltration Bottom Area	sf	1,261

Drawdown Time = Infiltration Area Storage Volume / [Design Infiltration Rate x Infiltration Area Bottom Area]

Drawdown Time (Hrs)	**4.7**

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Infiltration Area Requirements

139 Amesbury Line Road
Haverhill, MA
Project No. 181084

Drawdown Time

(Per Massachusetts Stormwater regulations, infiltration areas must completely drain within 72 hours)

		WQS4
Infiltration Area Storage Volume	cf	2
Design infiltration Rate	in/hr	0.27
Infiltration Bottom Area	sf	10

Drawdown Time = Infiltration Area Storage Volume / [Design Infiltration Rate x Infiltration Area Bottom Area]

Drawdown Time (Hrs)	**8.9**

LONG TERM POLLUTION PREVENTION PLAN & STORMWATER SYSTEM OPERATION AND MAINTENANCE PLAN

Haverhill Solar Project
139 Amesbury Line Road
Haverhill, MA

April 2021
Revised August 2021

<u>Submitted to:</u>
City of Haverhill Department of Public Works
City of Haverhill Conservation Commission
4 Summer Street
Haverhill, MA 01830

<u>Submitted by:</u>
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Summerville, SC 29483

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<u>PROJECT NO:</u>
181084

GPR Engineering Solutions for Land & Structures

LONG TERM POLLUTION PREVENTION PLAN & STORMWATER SYSTEM OPERATION AND MAINTENANCE PLAN HAVERHILL SOLAR PROJECT 139 AMESBURY LINE ROAD, HAVERHILL, MA

Preface:

The goal of this manual is to improve water quality by initiating performance standards for the operation and maintenance of stormwater management structures, facilities, and recognized practices. The stormwater performance standards are set up to meet the stormwater management regulations under 974 CMR 4.08 and the Department of Environmental Protection, including the Wetland Protection Act, surface water discharge permits under the Clean Waters Act, and the 401 certification of federal permits based on the water quality standards.

The local Conservation Commission and the Department of Environmental Protection are responsible for ensuring the protection of wetlands through the issuance of permits for activities in flood plains and in or near wetlands, as per the Wetlands Protection Act, MGL c.131 s. 40. Proposed work within a resource area or a one hundred (100') foot buffer zone requires an order of conditions. Local wetland bylaws require a 35' no-disturbance zone be preserved around wetlands.

This manual is set up to explain how to operate and maintain Best Management Practices that control erosion and minimize delivery of sediment and other pollutants to surrounding water and wetland resource areas.

Chapter 1	is an introduction to the site and describes the Best Management Practices used on this site.
Chapter 2	outlines the inspection and maintenance schedules for the site.
Chapter 3	is an 11x17 drawing showing the location of the Best Management Practices used on-site.
Chapter 4	outlines the operation and function of the Best Management Practices.
Chapter 5	describes how and when the Best Management Practices should be inspected and how frequently they must be maintained and cleaned.
Chapter 6	describes the interface with parallel maintenance practices for the solar facility itself.

1. Introduction:

The subject site area measures 18.40± acres and is within the 26.81± acre subject property shown on the City of Haverhill Assessors Map 430, Parcel 11. The subject site area is being leased for a Large-Scale Ground-Mounted Solar Energy System, and this 18.40± acre portion of Map 430, Parcel 11 is referred to as the "Solar Lease Area," and is the only area to which this O&M Plan applies.

The leased area at 139 Amesbury Line Road contains a Large-Scale Ground-Mounted Solar Energy System anticipated to produce 2± MW electrical power utilizing solar photovoltaic (PV) modules/panels. The project consists of solar panel modules secured to galvanized steel racking fastened to driven steel posts for support and anchorage. The facility is ringed by chain link fencing with locked access gates. A single 22' wide gravel access driveway from Amesbury Line Road passes through the main gate of the facility and proceeds inside the fence line to two vehicular turnarounds that do not loop. Pad-mounted electrical equipment and various other rack-mounted equipment such as wiring, conduits, inverters, transformers, etc, are also located within the fence line.
It is a potentially hazardous electrical area inside the fenceline that must be entered and maintained carefully with knowledge of all systems that are in operation.

Other environmental amenities such as an apiary and special seeding areas may also exist and like the electrical equipment, may have other maintenance requirements and restrictions listed elsewhere, not addressed in this Long Term Pollution Prevention Plan and Stormwater System Operations and Maintenance Plan – **seek out proper guidance elsewhere for maintaining electrical systems or other non-stormwater-related systems.**

Most of the stormwater facilities requiring maintenance are inside the fence line, but some maintenance items are outside the fenced perimeter, as noted on the BMP Locus Map.

This manual is designed to help responsible parties become aware of urban non-point pollution problems and to provide detailed information about operating and maintaining stormwater management practices. The success of the Best Management Practices is dependent on their continued operations and maintenance.

2. Maintenance Requirements:

BMP's Owners:

- The OWNERS of the BMP's shall be the person, persons, trust, corporation, etc., or their successors who hold the long term lease on the land on which the BMP is located. It is anticipated that all BMP's will be owned and maintained by **Solar Smart, LLC,** or its designees, under a land lease from the land owner, Mr. Theodore Xenakis.

Operation and Maintenance Responsibilities:

- The party or parties responsible for the funding, operation and maintenance of the BMP's shall be the OWNER or their designees.
- BMP's each have specific maintenance requirements to ensure long-term effectiveness. These stormwater management systems will be operated, inspected and maintained on a regular basis by normal maintenance personnel. Any repair or replacement of the on-site BMP's, or any questions relating to required maintenance of stormwater BMP's should be observed/answered **by a qualified professional with expertise in inspecting drainage system components**. All of the stormwater BMP's shall be kept in good working order at all times.
- A maintenance agreement providing for the funding, operation and maintenance of all the stormwater management BMP's shall be provided.
- Snow storage areas have been indicated on the BMP Locus Plan, however, the site will only receive limited traffic from solar maintenance, and it is not anticipated that disposal of snow from the site will be required.
- Gravel access driveway shall receive regrading or repairing as needed in order to maintain grading and properly convey runoff without causing channeling or erosion of slopes and drainage swales. Access driveway shall be inspected every spring and fall of every year. Note evidence of rutting or uneven areas and make grading adjustments or repairs as needed.

Source of Funding for Operation and Maintenance:

- The party or parties responsible for the funding, operation and maintenance of the BMP's shall be the OWNER or their designees.
- Approximate estimated annual maintenance costs for the site BMP's are:

- Culvert Headwalls	$50
- Catch Basins	$50 each
- Grass Swales	$300
- Stone Overflows	$300
- Conveyance Channels	$300
- Check Dams	$250
- Sediment Forebay	$50
- Water Quality Swales	$150 each
- Level Spreaders	$50 each
- Stone Diaphragms	$50
- Stone-Armored Channel	$50

Schedule for Inspection and Maintenance:

- Routine site inspections will be performed monthly for the first year and no less than annually thereafter.
- BMP's each have specific maintenance requirements to ensure long-term effectiveness. These stormwater management systems will be operated, inspected and maintained on a regular basis in accordance with this manual. All of the stormwater BMP's shall be kept in good working order at all times.
- As a minimum, the OWNER shall follow the general guidelines outlined herein for the BMP's provided on this site.
- An Operation and Maintenance log must be maintained in perpetuity, outlining inspections, repairs, replacement and/or disposal of each Best Management Practice (BMP). In the case of disposal of debris materials removed from BMP's that are to be disposed off-site, the log shall indicate the type of material being disposed of, and the disposal location. This rolling log shall be made available to the Mass DEP and/or the Haverhill Conservation Commission upon request.

3. Location of Best Management Practices (see plans sheets or the abbreviated BMP Locus Map in this document)

4. Operation of Best Management Practices:

The collective functions of all the Stormwater BMP measures include:

- Promoting groundwater recharge by providing pockets of storage volume that allow some water to infiltrate into soil;
- Providing distributed detention across the property;
- Controlling flow velocities with numerous energy breaks;
- Preventing erosion by limiting flow lengths of any localized rivulets;
- Lengthening total flow length and time of concentration, resulting in greater groundwater recharge and reduced peak discharges.

Stormwater BMP's on this site, and their specific functions consist of:

1. **Culvert Headwall** – Protect pipe ends from wear and maintenance damage.
2. **Catch Basin** – Collect concentrated surface flow and convey to piped outlet.
3. **Grass Swales** – Convey flow and temporarily store runoff to promote recharge.
4. **Stone Overflows & Spillways** – Provide a stable outlet for flows that exceed a storage volume.
5. **Conveyance Channels**- Provide a stable, concentrated flow path for drainage, particularly when combined with check dams, turf stabilization or other fabric and stone armoring combinations.
6. **Check Dams**- Provide energy dissipation of flowing water and slowly releases flow through the uncompacted stone.
7. **Sediment Forebay** – Provides coarse removal of total suspended solids, and in conjunction with other BMP's improves water quality.
8. **Water Quality Swales (with Outlet Control Structures)** – Provide larger defined storage volumes that are slowly released via control structures and outlet pipes to reduce peak flow discharges.
9. **Level Spreaders** – Provide a maintainable structural outlet from piped discharges or overflows, in order to produce non-erosive sheet flow discharges.
10. **Stone Diaphragm** – Provide a relatively small storage volume, flush to grade that can provide a measure of groundwater recharge and conveyance, and also serve as a level spreader outlet device.
11. **Stone-Armored Channel**- Functions as an erosion and sedimentation control measure for concentrated flow.

5. Inspection and Maintenance of Best Management Practices:

Upon the completion of construction, inspections must be conducted monthly for the first year to ensure adequate stabilization and function with appropriate adjustments and repairs made in a timely fashion to avoid excessive degradation. Regular maintenance thereafter is as listed below.

For all maintenance practices that involve the removal of debris from the subject Solar Lease Area, collected sediment and debris will be properly disposed of per local, state and federal requirements. Any sediment and debris removed from a catch basin deemed to be contaminated must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

Culverts and Culvert Headwalls– are pipe connections to convey water from one open flow condition to another. The inspection and maintenance procedures for this measure include:

- Inspect twice a year, Spring and Fall, after 1st year.
- Remove collected debris and sediments from inlet and outlets.
- Repair rutting or erosion at the inlet or outlet.
- Observe any deformations in the pipe and headwalls and if the pipe is crushed or structurally damaged, repair or replace as appropriate.

Catch Basins– are drainage structures topped with a grate that has the function of collecting stormwater and transporting it via underground piping to other areas on site.There are two catch basins along the entry driveway, both outside the fence line. The inspection and maintenance procedures for this measure include:

- Inspect twice a year, Spring and Fall, after 1st year.
- Remove collected debris and sediments from sump.
- Observe any deformations or damage in structure. Repair or replace as needed.

Grass Swales- are nearly level, flat sloped (<0.5%) ditches set parallel to grade contours, or perpendicular to the gradient of the hillside slopes, intended to capture sheet flow from limited upland areas, and temporarily hold the water for recharging to groundwater. Each Grass Swale slopes towards a single Stone Overflow that discharges a controlled flow to a Conveyance Channel.
The inspection and maintenance procedures for this measure include:

- Inspect annually, after 1st year.
- Remove sediment from grass channel annually.
- Mow once a month during growing seasons, or as warranted by site conditions.
- Revegetate as needed for permanent cover.
- Inspect Stone Overflow – See **Stone Overflows & Check Dams.**

Stone Overflows & Check Dams– are barriers to slow concentrated flow in swales, ditches and channels consisting of a core of stone (in Check Dams) or soil (in Stone Overflow), overlaid with geotextile fabric and a covering later of larger stone. The inspection and maintenance procedures for this measure include:

- Inspect annually, after 1st year.
- Remove accumulated sediments and debris at the upstream base.
- Remove collected debris from the topping stone.
- Repair rutting or erosion at the stone edges where the Overflow or Check Dam is keyed into the adjacent earthen areas.
- Restore or replace shifted rock or stone for proper erosive armoring or overflow.
- Water Quality Swale #4 has a wider (10' width) stone overflow that activates at the 100-year storm event and should be maintained in a similar fashion as the remainder of the stone overflows and check dams.

Conveyance Channels- are sloped ditches intended to convey a range of flows and control erosive velocities and sediment transport with multiple check dams. The inspection and maintenance procedures for this measure include:

- Inspect annually, after 1st year.
- Remove debris and accumulated sediments annually.
- Mow annually or as needed during growing seasons to prevent shading.
- Revegetate as needed for permanent cover.
- Inspect Check Dams - See **Stone Overflows & Check Dams.**

Sediment Forebay – is a small stormwater runoff impoundment to capture coarse debris and suspended solids for pre-treatment in a water quality treatment train, with a check dam outlet. The inspection and maintenance procedures for this measure include:

- Inspect twice a year, after 1st year.
- Remove debris and accumulated sediments.
- Repair rutting or erosion, particularly at the Check Dam outlet.
- Cut out and remove woody growth and stems.

Water Quality Swales (with Outlet Control Structures) - are stormwater runoff impoundments with outlet control structures that slow the release of the impoundment volume. The inspection and maintenance procedures for this measure include:

- Inspect twice a year, Spring and Fall, after 1st year.
- Remove debris and accumulated sediments from inside the swales and from surrounding stone-armored areas.

- Repair rutting or erosion, particularly at the outlet control structure.
- Cut out and remove woody growth and stems, inside the impoundment, from the top of the embankment, and on the embankment itself.
- Mow once a month during growing seasons, or as warranted by site conditions.

Level Spreaders– consist of large, perforated pipes set parallel to the receiving grade, partially buried and stone covered to dissipate energy and convert concentrated flow to non-erosive sheet flow. The inspection and maintenance procedures for this measure include:

- Inspect annually, after 1st year.
- Remove accumulated debris sufficiently to expose the stone armoring.
- Repair rutting or erosion at the stone edges.
- Restore or replace shifted rock or stone for proper erosive armoring.
- Revegetate as needed.

Stone Diaphragms and Swales– are excavated trenches lined with geotextile fabric and filled with stone, set flush to surrounding grades. The Stone Diaphragms on this project have perforated pipes embedded in the stone to promote capture, flow and recharge or overflow of captured surface waters. The inspection and maintenance procedures for this measure include:

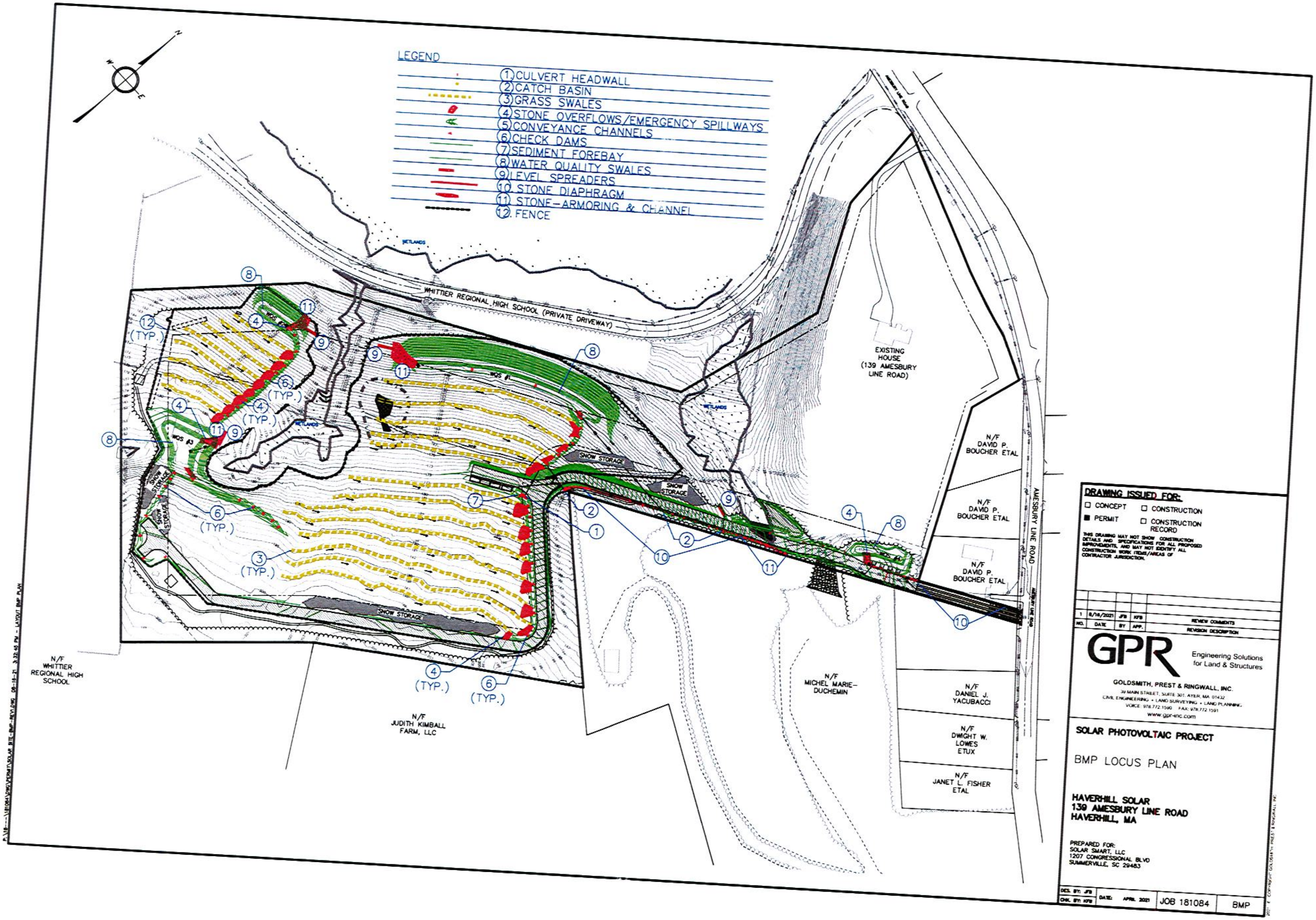
- Inspect annually, after 1st year.
- Remove accumulated debris sufficiently to expose the surficial stone.
- Repair rutting or erosion at the stone edges.
- Restore or replace transported rock or stone on top of the diaphragm limits.

Stone Armored Channel– is a basic erosion control measure consisting of stone on geotextile fabric to promote non-erosive flow in a ditch. There is only a short section of this treatment along the entry driveway. The inspection and maintenance procedures for this measure include:

- Inspect annually, after 1st year.
- Remove accumulated debris sufficiently to expose the surficial stone.
- Repair rutting or erosion at the stone edges.
- Restore or replace transported rock or stone on top of the diaphragm limits.

6. Solar Facility Maintenance Notes:

Solar Facility Maintenance is detailed in other documents by **Solar Smart, LLC**, which includes a schedule for solar equipment inspection and maintenance, fence maintenance, driveway maintenance, and may include maintenance of other environmental features such as observation platforms, apiary and specialty seeding areas. Caution and care must be exercised in all use of hand tools and mechanical maintenance equipment so as not to damage any portion of the solar facility equipment or amenities. If any damage occurs to any portion of the land or solar facility equipment, or if suspected damage of any kind is identified or suspected upon observance, the Owner must be notified immediately.


LEGEND
1 CULVERT HEADWALL
2 CATCH BASIN
3 GRASS SWALES
4 STONE OVERFLOWS/EMERGENCY SPILLWAYS
5 CONVEYANCE CHANNELS
6 CHECK DAMS
7 SEDIMENT FOREBAY
8 WATER QUALITY SWALES
9 LEVEL SPREADERS
10 STONE DIAPHRAGM
11 STONE-ARMORING & CHANNEL
12 FENCE
N
WHITTIER REGIONAL HIGH SCHOOL (PRIVATE DRIVEWAY)
WETLANDS
EXISTING HOUSE (139 AMESBURY LINE ROAD)
AMESBURY LINE ROAD
N/F DAVID P. BOUCHER ETAL
N/F DAVID P. BOUCHER ETAL
N/F DAVID P. BOUCHER ETAL
N/F DANIEL J. YACUBACCI
N/F DWIGHT W. LOWES ETUX
N/F JANET L. FISHER ETAL
N/F MICHEL MARIE-DUCHEMIN
N/F JUDITH KIMBALL FARM, LLC
N/F WHITTIER REGIONAL HIGH SCHOOL
SNOW STORAGE
(TYP.)
DRAWING ISSUED FOR:
CONCEPT
CONSTRUCTION
PERMIT
CONSTRUCTION RECORD
THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.
1 6/16/2021 JFB KFB REVIEW COMMENTS
NO. DATE BY APP. REVISION DESCRIPTION
GPR
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SOLAR PHOTOVOLTAIC PROJECT
BMP LOCUS PLAN
HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA
PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483
DES. BY: JFB
CHK. BY: KFB
DATE: APRIL 2021
JOB 181084
BMP

Best Management Practices (BMP) Inspection Log

General Information	
Project Name	Haverhill *Solar Smart* Solar Project
Location	139 Amesbury Line Rd, Haverhill, MA
Date of Inspection	
Inspector's Name(s)	**Start/End Time**
Inspector's Title(s)	
Inspector's Contact Information	
Inspector's Qualifications	
Type of Inspection: ❑ Regular ❑ Emergency	
Weather Information	
Weather at time of this inspection? ❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds ❑ Other: Temperature:	
Are there any discharges at the time of inspection? ❑Yes ❑No **If yes, describe:**	

Site-specific BMPs

- *The structural BMPs are identified on the BEST MANAGEMENT PRACTICES LOCUS included within the LONG TERM POLLUTION PREVENTION & STORMWATER SYSTEM OPERATION & MAINTENANCE PLAN. Carry a copy of the Locus map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.*
- *Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.*

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1		❑Yes ❑No	❑Yes ❑No	
2		❑Yes ❑No	❑Yes ❑No	
3		❑Yes ❑No	❑Yes ❑No	
4		❑Yes ❑No	❑Yes ❑No	
5		❑Yes ❑No	❑Yes ❑No	
6		❑Yes ❑No	❑Yes ❑No	
7		❑Yes ❑No	❑Yes ❑No	
8		❑Yes ❑No	❑Yes ❑No	
9		❑Yes ❑No	❑Yes ❑No	
10		❑Yes ❑No	❑Yes ❑No	

Overall Site Issues

Below are some general site issues that should be assessed during inspections. Customize this list as needed for conditions at your site.

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
1	Are discharge points and receiving waters free of any sediment deposits?	❑Yes ❑No	❑Yes ❑No	
2	Are storm drain inlets properly working?	❑Yes ❑No	❑Yes ❑No	
3	Is trash/litter from site areas collected and placed in covered dumpsters?	❑Yes ❑No	❑Yes ❑No	
4	Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No	❑Yes ❑No	
5	Are materials that are potential stormwater contaminants stored inside or under cover?	❑Yes ❑No	❑Yes ❑No	
5	Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	❑Yes ❑No	❑Yes ❑No	
6	(Other)	❑Yes ❑No	❑Yes ❑No	

Non-Compliance

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name and title: ____

Signature:____________________________________ **Date:**______________

SITE PLAN

HAVERHILL SOLAR PROJECT

HAVERHILL, MA

REGULATORY NOTES

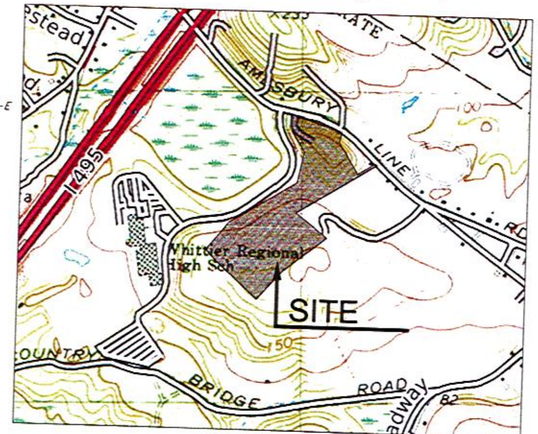
1. CONTRACTOR SHALL CONTACT DIG-SAFE FOR UNDERGROUND UTILITY MARKING AT 888.344.7233 AT LEAST 72 HOURS PRIOR TO COMMENCEMENT OF ANY WORK. CONTRACTOR SHALL GIVE TWENTY-FOUR (24)-HOUR NOTICE TO PERTINENT TOWN DEPARTMENTS BEFORE COMMENCING ANY WORK IN THE FIELD.
2. CONTRACTOR SHALL COORDINATE AND OBTAIN ALL CONSTRUCTION PERMITS REQUIRED BY REGULATORY AUTHORITIES. DPW INSPECTIONS OF DRIVEWAY, WATER, SEWER AND DRAINAGE CONSTRUCTION AT CURRENT INSPECTION FEE RATES IS REQUIRED.
3. CONTRACTOR SHALL BE AWARE OF ALL CONSTRUCTION REQUIREMENTS, CONDITIONS, AND LIMITATIONS IMPOSED BY PERMITS AND APPROVALS ISSUED BY REGULATORY AUTHORITIES PRIOR TO COMMENCEMENT OF ANY WORK.
4. GENERAL COMPLIANCE WITH 28 CFR PART 36 – 2010 ADA STANDARDS FOR ACCESSIBLE DESIGN AND 521 CMR PART C, EXTERIOR OF THE MASSACHUSETTS ARCHITECTURAL ACCESS BOARD REGULATIONS IS INTENDED. CONTRACTOR SHALL VERIFY COMPLIANCE DURING CONSTRUCTION AND SHALL NOTIFY THE OWNER OF ANY NON-COMPLIANCE ISSUES AS SOON AS DISCOVERED.
5. LEDGE REMOVAL VIA BLASTING SHALL CONFORM TO 527 CMR 1.00 AND INCORPORATE THE HAVERHILL DPW LEDGE BLASTING SPECIFICATIONS.

SITE DATA

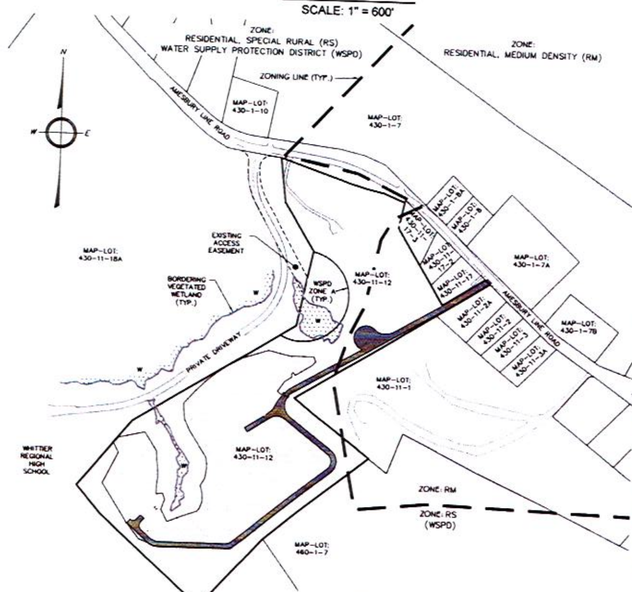
LOT AREA:	26.8 ±AC. (1,167,844 S.F.)
OPEN SPACE:	93% ±
SOLAR LEASE AREA:	18.4 ± AC (801,504 S.F.)

GENERAL NOTES

1. THE INTENT OF THIS SITE PLAN IS TO INSTALL A LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM, DRIVEWAY ENTRANCE AND GRAVEL DRIVEWAY WITH ALL REQUISITE FENCING, STORMWATER MANAGEMENT, AND OTHER APPROPRIATE INFRASTRUCTURE. THE DRIVEWAY WILL BE USED FOR ON-GOING, INFREQUENT ACCESS BY VEHICLES FOR THE PURPOSE OF ROUTINE MAINTENANCE OF THE SOLAR SYSTEM.
2. OVERHEAD POWER LINES ARE PROPOSED ADJACENT TO THE DRIVEWAY AND THE LOCATIONS OF POLES ARE SUBJECT TO FINAL ENGINEERING BY NATIONAL GRID.
3. LOCATIONS OF EXISTING UNDERGROUND UTILITIES/OBSTRUCTIONS/SYSTEMS SHOWN HEREON ARE APPROXIMATE ONLY. ALL UTILITIES/OBSTRUCTIONS/SYSTEMS MAY NOT BE SHOWN. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL UNDERGROUND UTILITIES/OBSTRUCTIONS/SYSTEMS, WHETHER OR NOT SHOWN HEREON.
4. UNLESS OTHERWISE SHOWN, ALL NEW UTILITIES SHALL BE UNDERGROUND.
5. BURIED UTILITIES SHALL BE INSTALLED IN ACCORDANCE WITH THEIR RESPECTIVE COMPANY SPECIFICATIONS.
6. CONSTRUCTION LAYOUT OF SITE IMPROVEMENTS SHALL BE PERFORMED BY A LICENSED PROFESSIONAL LAND SURVEYOR. LOCATIONS OF EXISTING FEATURES OR PROPOSED IMPROVEMENTS DERIVED BY SCALING DRAWINGS MAY NOT BE ACCURATE. PROPERTY LINES SHOWN HEREON ARE APPROXIMATE. SEE PLAN REFERENCE HEREON.
7. SAFETY MEASURES, CONSTRUCTION METHODS, AND CONTROL OF WORK SHALL BE RESPONSIBILITY OF CONTRACTOR.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR AND/OR REPLACEMENT OF ANY EXISTING UTILITY OR STRUCTURE DAMAGED DURING CONSTRUCTION THAT ARE NOT DESIGNATED FOR DEMOLITION AND/OR REMOVAL HEREON. DAMAGED UTILITY OR STRUCTURE SHALL BE REPAIRED TO THE SATISFACTION OF THEIR RESPECTIVE OWNERS.
9. ANY INTENDED REVISION OF THE HORIZONTAL AND/OR VERTICAL LOCATION OF IMPROVEMENTS TO BE CONSTRUCTED AS SHOWN HEREON SHALL BE REVIEWED AND APPROVED BY ENGINEER PRIOR TO IMPLEMENTATION.
10. CONTRACTOR SHALL NOTIFY ENGINEER UPON COMMENCEMENT OF CONSTRUCTION IN ORDER TO ENSURE THAT REQUIRED INSPECTIONS ARE PERFORMED IN A TIMELY AND EFFICIENT MANNER.
11. CONTRACTOR SHALL PROMPTLY NOTIFY ENGINEER UPON DISCOVERY OF ANY UNFORESEEN SURFACE OR SUBSURFACE CONDITIONS THAT MAY IMPACT SITE CONSTRUCTION.
12. FINISH RIM ELEVATIONS SHOULD MATCH PAVEMENT, GRADING OR LANDSCAPING, UNLESS SPECIFICALLY INDICATED OTHERWISE.
13. WHERE EXISTING UTILITY LINES/STRUCTURES ARE TO BE CUT/BROKEN DOWN/ABANDONED, LINES/STRUCTURES SHALL BE PLUGGED/CAPPED/FILLED IN ACCORDANCE WITH UTILITY OWNER REQUIREMENTS.
14. EROSION CONTROL MEASURES, SUCH AS SILT FENCE OR STRAW BALES AS MAY BE SHOWN HEREON, SHALL BE INSTALLED BEFORE EARTH DISTURBANCE OCCURS WITHIN BUFFER ZONE, AND SHALL SERVE AS THE LIMIT OF WORK.
15. WHERE THE WORD "INSTALL" IS USED HEREIN, IT IS INTENDED TO DIRECT CONTRACTOR TO "FURNISH, INSTALL, AND PLACE IN OPERATION" THE COMPONENT REFERRED TO.
16. LIMITS OF WORK SHALL BE STAKED IN THE FIELD PRIOR TO COMMENCEMENT OF CONSTRUCTION.
17. ALL STORM DRAIN PIPE TO BE SMOOTH INTERIOR HDPE PIPE, 2.0 PSI GASKETED JOINT, UNLESS OTHERWISE NOTED.
18. WHERE SHOWN, CONSTRUCTION NOTES ARE INTENDED TO SUMMARIZE AND CLARIFY MAJOR ITEMS OF WORK. THESE NOTES SHOULD NOT BE CONSTRUED AS AN EXHAUSTIVE LISTING OF ALL WORK REQUIRED. CONTRACTOR SHOULD CONTACT ENGINEER WHEN FURTHER CLARIFICATION OF DEPICTED WORK IS DESIRED.
19. NO DEBRIS, JUNK, RUBBISH OR OTHER NON-BIODEGRADABLE MATERIALS, FILL CONTAINING HAZARDOUS MATERIALS OR WASTES, OR STUMPS SHALL BE BURIED ON ANY LAND ON THIS SITE, OR LEFT ON ANY LOT OR ON THE STREET RIGHT OF WAY.



VICINITY MAP
SCALE: 1" = 600'



OVERALL MAP & ZONING
SCALE: 1" = 250'

SHEET INDEX

ASSESSORS REFERENCE

ASSESSORS MAP 430, BLOCK 11, LOT 12

SUBMITTALS

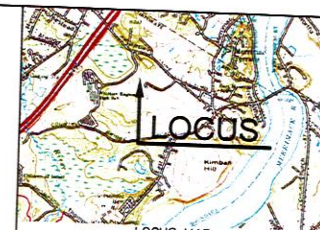
1. COORDINATE POWER AND COMMUNICATIONS SERVICE WITH UTILITY COMPANIES. SUBMIT UTILITY GENERATED LAYOUT PLAN TO ENGINEER FOR APPROVAL PRIOR TO ANY CONSTRUCTION.
2. SUBMIT REQUEST FOR SPECIAL PERMIT FOR CONSTRUCTION OF LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM TO CITY COUNCIL.
3. SUBMIT REQUEST FOR SPECIAL PERMIT FOR CONSTRUCTION IN WATER SUPPLY PROTECTION DISTRICT (WSPD) TO CITY COUNCIL.
4. SUBMIT SITE PLAN TO CITY OF HAVERHILL DEVELOPMENT REVIEW FOR CONSTRUCTION OF LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM.
5. SUBMIT NOTICE OF INTENT TO CITY OF HAVERHILL CONSERVATION COMMISSION FOR REVIEW FOR WORK THAT FALLS UNDER THE MASSACHUSETTS WETLAND PROTECTION ACT AND CITY OF HAVERHILL WETLAND PROTECTION ORDINANCE.

ZONING

Parameter	Section [1]	Requirement	Remarks
Zoning District	2.1.1 & Zoning Map	RS / RM	Special Rural (residential) & medium density (residential)
Overlay District	2.1.2 & Zoning Map	WSPD	WSPD (Water Supply Protection District)
			9.2.7
Proposed Use	7.8.3	Allowed by SPGA	Large-Scale Ground-Mounted Solar Energy Systems
		RS / RM	
Lot Area	Appendix B-Table 2	87,120 SF / 20,000 SF	1,167,844 SF
Frontage	Appendix B-Table 2	200 FT / 150 FT	583 FT
Lot Depth	Appendix B-Table 2	150 FT / 100 FT	1900 FT
Yard	Appendix B-Table 2	Special / residential / solar	Use Solar Dimensions
Front	Appendix B-Table 2	40 FT / 25 FT / 100 FT	100 FT (7.8.6-1.a.)
Side	Appendix B-Table 2	25 FT / 15 FT / 100 FT	100 FT (7.8.6-1.b.)
Rear	Appendix B-Table 2	25 FT / 30 FT / 100 FT	100 FT (7.8.6-1.c.)
Building Height	Appendix B-Table 2	35 FT / 35 FT	N/A
Maximum Stories	Appendix B-Table 2	2.5 / 2.5	N/A
Building Coverage	Appendix B-Table 2	15 % / 25 %	N/A
Floor Area Ratio	Appendix B-Table 2	None	N/A
Open Space (MIN.)	Appendix B-Table 2	70 % / 45 %	93.95%
Parking	9.3.15	see table	
Driveways and Entrances	7.8.7	see bylaw	
Wetlands Setback	253-8	100 feet from resource area	35' no disturbance, 75' no structure
Zone A, B, C	255-18		See Resource Impact Map (sheet C3.2)
MDEP Riverfront Area	N/A		none on site
FEMA Floodplain	25009C0092F		none on site
ACEC	N/A		none on site
NHESP	N/A		none on site
Zone 1 Protective Radius	N/A		none on site
Mapped Zone 2	N/A		none on site
IWPA	N/A		none on site

NOTES:
[1] Reference to section of Zoning Bylaw, where applicable.

ABBREVIATIONS:
SF=square feet; CF=cubic feet; FT=feet; GFA=gross floor area; GPD=gallons per day; AC=acres; WSPD=Water Supply Protection District; ZBA=Zoning Board of Appeals; SPGA=Special Permit Granting Authority



LOCUS MAP
1" = 2000'

ELEVATION DATUM

DATUM: NAVD 1988

B.M. NO.1

EXISTING CONDITIONS NOTES:

1. EXISTING CONDITION INFORMATION BASED ON AN ON-THE-GROUND TOPOGRAPHIC AND BOUNDARY SURVEY PERFORMED BY GOLDSMITH, PREST & RINGWALL, INC. OCTOBER 2020.
2. EDGE OF WETLAND DELINEATED BY MATTHEW MARRO–PRINCIPAL CONSULTANT OF MATTHEW S. MARRO ENVIRONMENTAL CONSULTING, DATED OCTOBER 2020.

PLAN REFERENCES

A. "EFFLUENT SEWER AND GROUND RECHARGE BEDS" BY DRUMMEY ROSANE ANDERSON (DRA) OF NEWTON LOWER MASS, DATED 1/4/79, PROVIDED BY WHITTIER SCHOOL.

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION
■ PERMIT ☐ CONSTRUCTION RECORD

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COMMONWEALTH OF MASSACHUSETTS NICHOLAS M. PAULING CIVIL No. 47114 REGISTERED PROFESSIONAL ENGINEER
4/8/2021

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NO	DATE	BY	APP.	REVISION DESCRIPTION

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SOLAR PHOTOVOLTAIC PROJECT

TITLE SHEET

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C1.1
CHK. BY: KFB			

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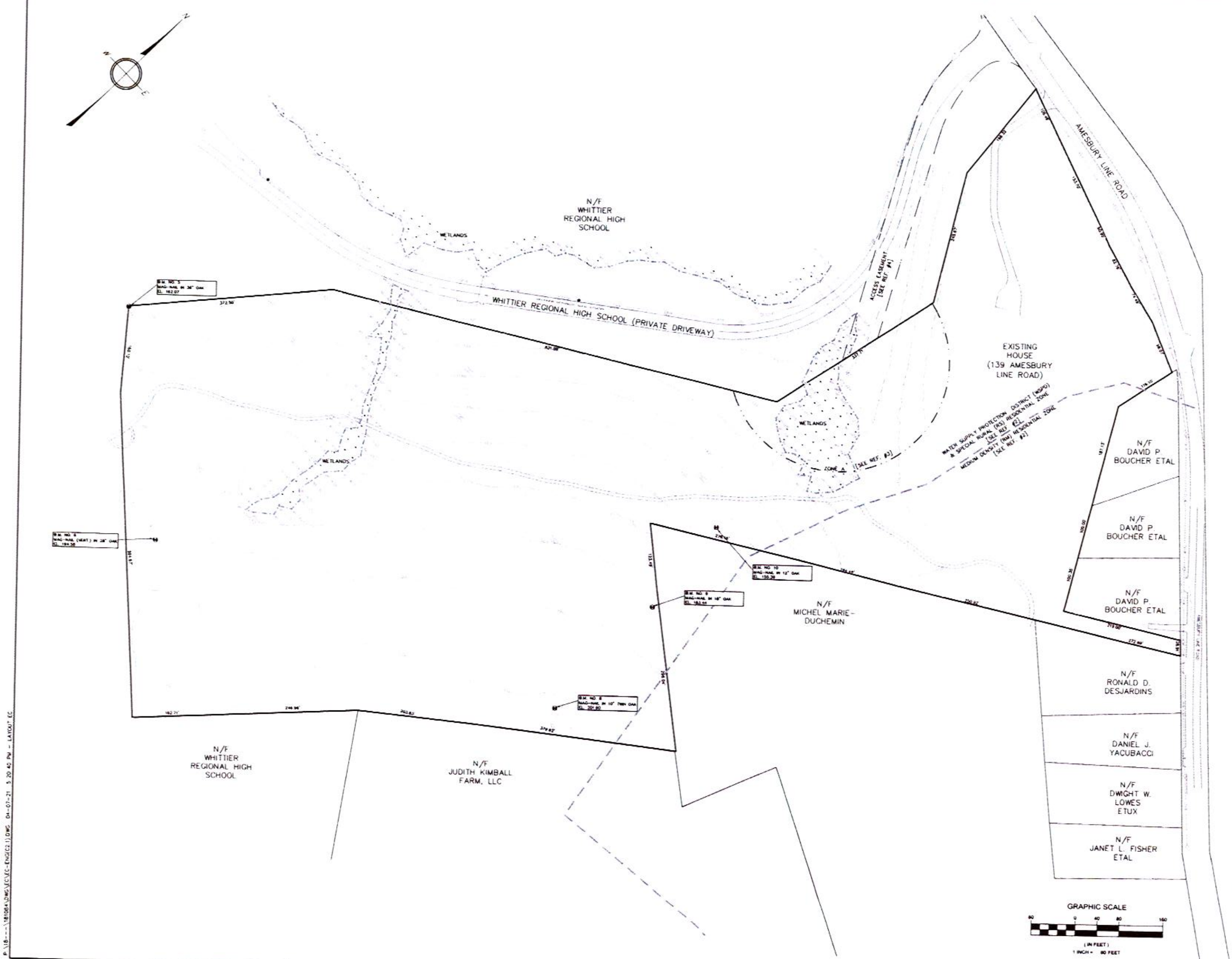

LEGEND

EXISTING

- ELEVATION CONTOUR
- SPOT GRADE
- PROPERTY LINE
- WETLAND DELINEATION
- EDGE OF PAVEMENT
- GRAVEL/DIRT TRAIL
- CAPE COD BERM CURBING
- STONE WALL
- WATER VALVE
- FIRE HYDRANT
- GRAVITY SEWER LINE
- SEWER MANHOLE
- OVERHEAD POWER LINE
- UTILITY POLE
- STORM DRAIN
- DRAIN MANHOLE
- DEEP SOIL OBSERVATION HOLE
- ELEVATION BENCHMARK
- EDGE OF TREELINE

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

PLAN REFERENCES

1. "PLAN OF LAND IN HAVERHILL, MASS." DRAWN FOR THEODORE XENAKIS BY MERRIMACK ENGINEERING SERVICES. DATED DECEMBER 1981. ESSEX DISTRICT REGISTRY OF DEEDS PLAN BOOK 176, PLAN 36.
2. "CITY OF HAVERHILL MASSACHUSETTS ZONING WITH WATERSHED & INDEX MAP-2017" BASED ON PLAN OVERLAY PROVIDED BY THE HAVERHILL DEPARTMENT OF ECONOMIC DEVELOPMENT & PLANNING.
3. EDGE OF ZONE A BASED ON PLAN OVERLAY PROVIDED BY OLIVER: MASS GIS.
4. "PLAN OF LAND IN HAVERHILL MASS SHOWING EASEMENT LOCATION" PREPARED BY STOWERS ASSOCIATES REG LAND SURVEYORS. DATED MARCH 1970. ESSEX REGISTRY OF DEEDS PLAN BOOK 116 PLAN 76

ASSESSORS REFERENCE:

ASSESSORS MAP 430, PARCEL 11, LOT 12, 26.8 ACRES

EXISTING CONDITIONS NOTES:

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DAVID DARBY 33867

4/8/2021

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SOLAR PHOTOVOLTAIC PROJECT

EXISTING CONDITIONS

HAVERHILL SOLAR
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HAVERHILL, MA

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SUMMERVILLE, SC 29483

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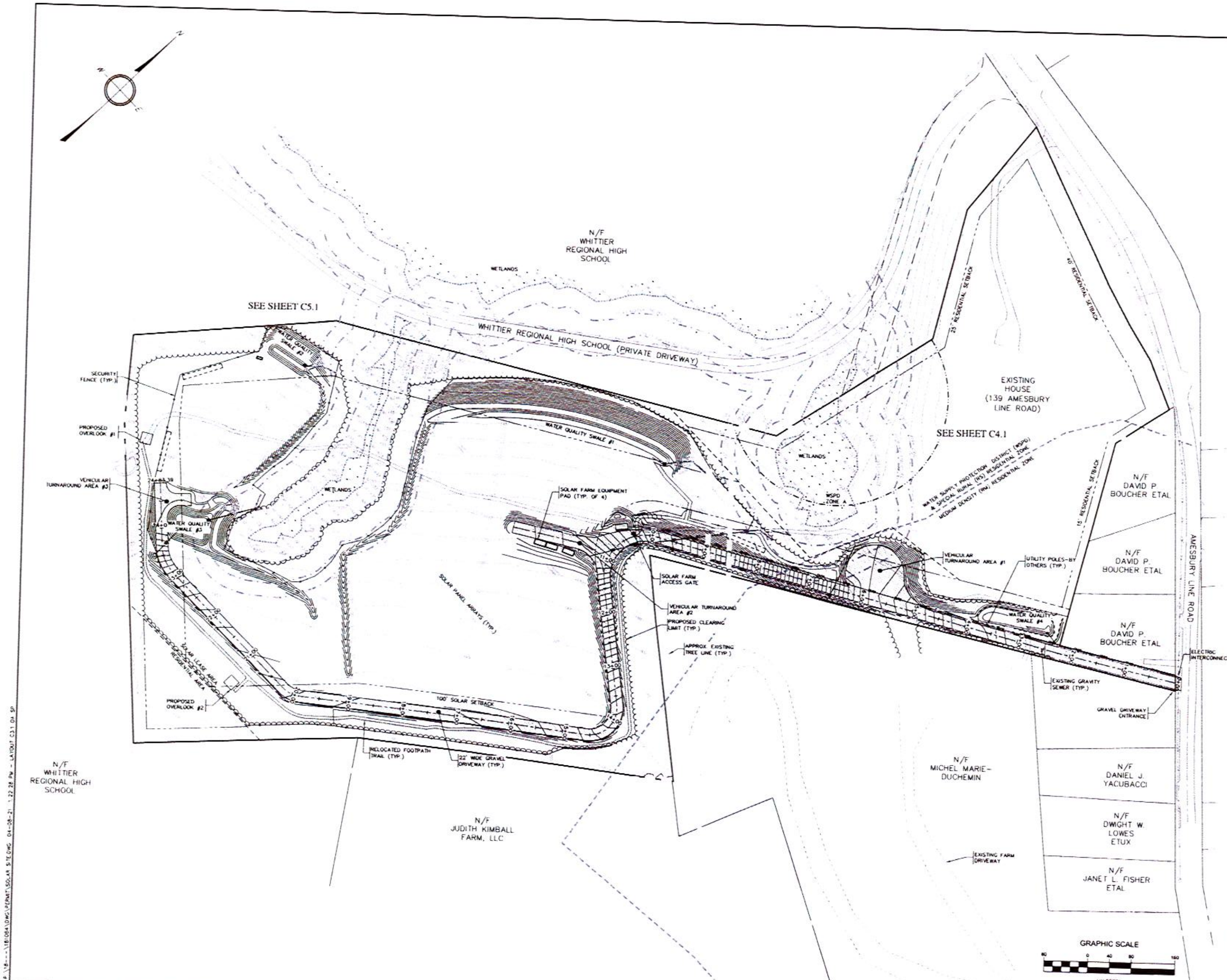

LEGEND

EXISTING — PROPOSED

- ELEVATION CONTOUR
- SPOT GRADE
- PROPERTY LINE
- WETLAND DELINEATION
- WETLAND BUFFER ZONE
- SHORELINE
- SOLAR LEASE AREA
- PROPERTY LINE SETBACK
- 100-YEAR FLOODPLAIN LIMIT
- EDGE OF PAVEMENT
- CAPE COD BERM CURBING
- GRANITE CURBING
- GRAVEL/DIRT ROAD
- STOCKADE FENCE
- STONE WALL
- WATER MAIN
- WATER SERVICE
- FIRE SERVICE
- WATER VALVE
- FIRE HYDRANT
- FORCE MAIN
- GRAVITY SEWER LINE
- SEWER MANHOLE
- GAS LINE
- GAS SERVICE
- GAS VALVE
- BURIED POWER LINE
- OVERHEAD POWER LINE
- UTILITY POLE
- GUY WIRE
- ELECTRIC BOX
- STORM DRAIN
- UNDERDRAIN
- ROOF DRAIN
- FOUNDATION DRAIN
- CATCH BASIN
- DRAIN MANHOLE
- DEEP SOIL OBSERVATION HOLE
- MAILBOX
- SITE LUMINAIRE
- SIGN
- ELEVATION BENCHMARK
- SURFACE RUNOFF DIRECTION
- STONE BOUND
- DRILL HOLE
- IRON ROD

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
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COMMONWEALTH OF MASSACHUSETTS NICHOLAS M. PAULING CIVIL No. 47114 REGISTERED PROFESSIONAL ENGINEER

Nicholas Pauling 4/8/2021

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OVERALL SITE PLAN

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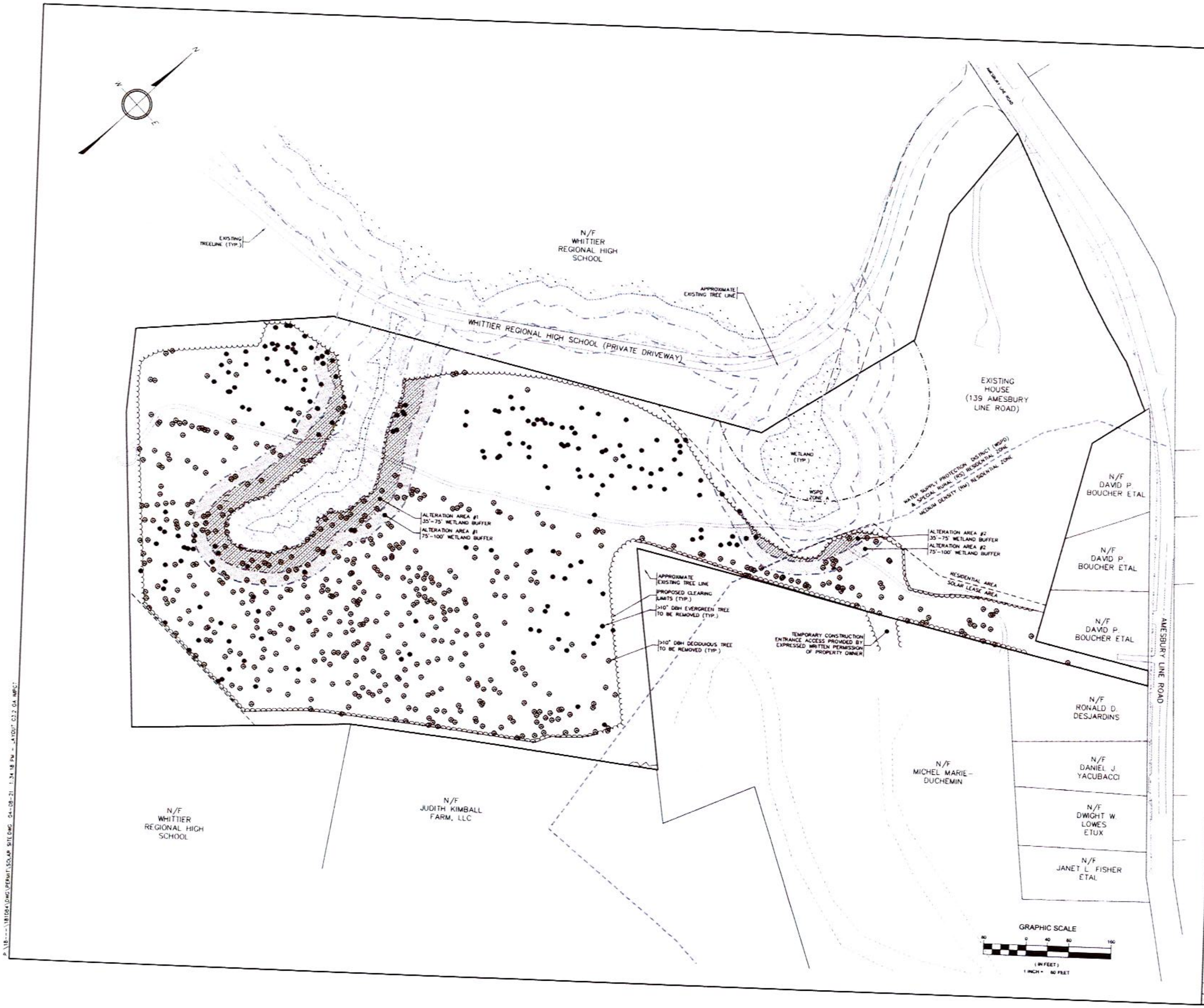

RESOURCE IMPACT MAP LEGEND

- 35'-75' WETLAND BUFFER ALTERATION
- 75'-100' WETLAND BUFFER ALTERATION
- TREE AND VEGETATION REMOVAL

RESOURCE IMPACT SUMMARY

WETLAND AREAS	
DISTURBED AREA	0
35'-75' WETLAND BUFFER	
AREA #1	43,012
AREA #2	3,764
75'-100' WETLAND BUFFER	
AREA #1	29,649
AREA #2	9,767
TOTAL	86,392 S.F.

WSPD IMPACT SUMMARY

WSPD ZONE A	
DISTURBED AREA	0
WSPD ZONE C	
DISTURBED AREA	595,295
TOTAL	595,295 S.F.

TREE IMPACT SUMMARY

TREES 10" DBH OR GREATER TO BE REMOVED

TOTAL 745 TREES

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SOLAR PHOTOVOLTAIC PROJECT

RESOURCE IMPACT MAP

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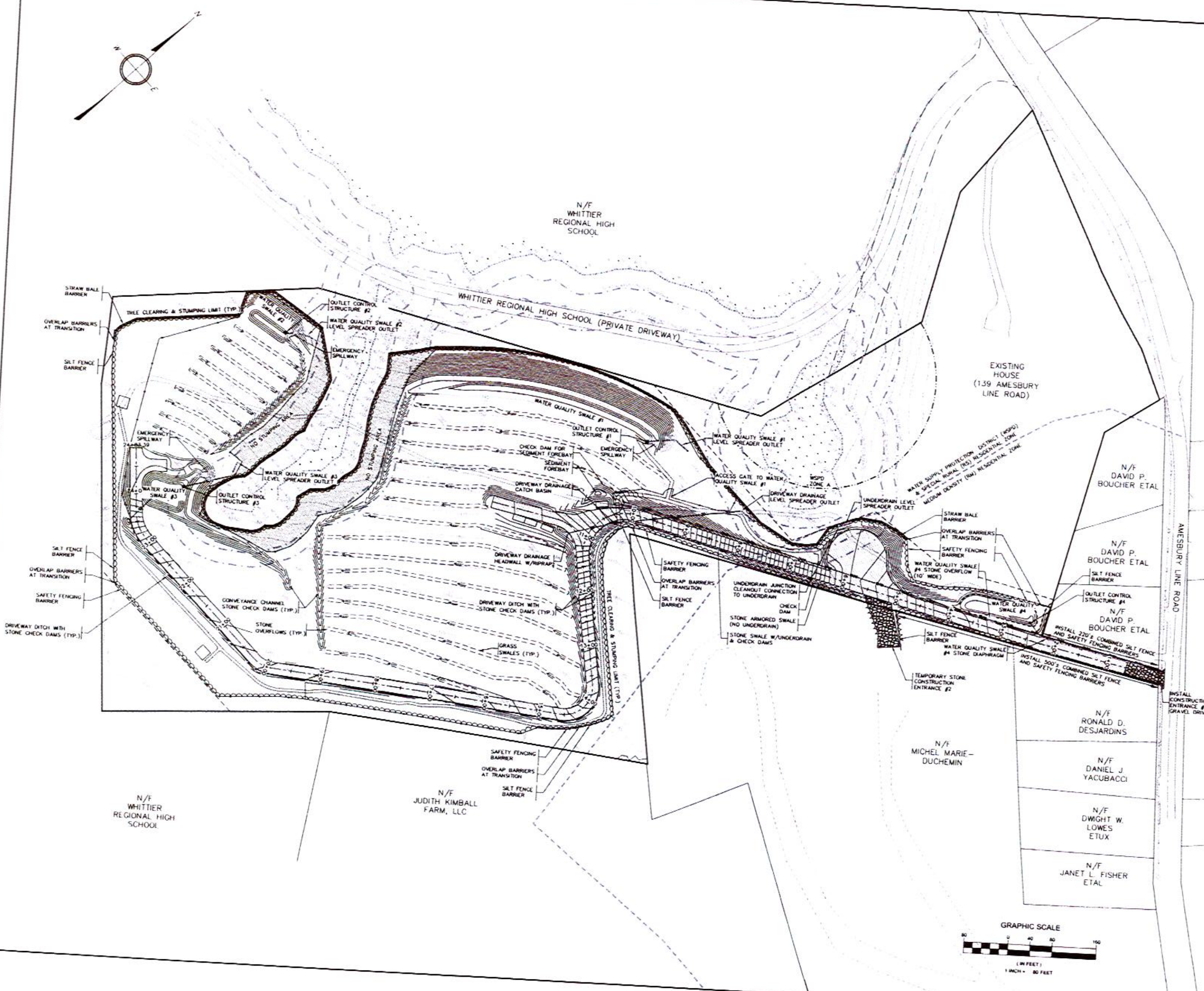

EROSION AND SEDIMENT MAP LEGEND

PROPOSED "NO STUMPING" AREA
PROPOSED DRIVEWAY
PROPOSED GRASS SWALE

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SOLAR PHOTOVOLTAIC PROJECT

EROSION AND SEDIMENT CONTROL PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C3.3
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EROSION AND SEDIMENT CONTROL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. FURNISH, INSTALL, AND MAINTAIN TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES ACROSS ALL AND EVERY GROUND SURFACE THAT IS ALTERED BY CONSTRUCTION THAT IS NOT OTHERWISE PERMANENTLY STABILIZED BY PERMANENT DRIVEWAY SURFACES. TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES SHALL CONSIST OF, BUT NOT NECESSARILY LIMITED TO, STRAW BALE AND SILT FENCE BARRIERS, RIPRAP, SILT BAGS, DIVERSION CHANNELS AND BERMS, BYPASS PUMPS/INTAKE FILTERS/HOSES, CHECK DAMS, STRATEGICALLY LOCATED STOCKPILES, SEDIMENT BASINS, MULCH, LOAM AND SEED MIX (HEREINAFTER "CONTROL MEASURES") ADEQUATE TO PREVENT THE CONVEYANCE OF EROSION PRODUCTS (E.G. SOIL, MULCH, SOD) OFF SITE, OR INTO ENVIRONMENTALLY SENSITIVE AREAS, OR INTO AREAS WHERE WORK WILL BE ADVERSELY IMPACTED. ENVIRONMENTALLY SENSITIVE AREAS INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, WETLANDS, TRIBUTARIES TO WETLANDS, WETLAND BUFFER ZONES, INTERMITTENT AND PERENNIAL STREAMS / RIVERS, AND THEIR ATTENDANT BUFFER ZONES.

1. REFER TO DRAWINGS FOR LOCATION AND DETAILS OF CONTROL MEASURES REQUIRED TO COMMENCE WORK. THESE CONTROL MEASURES WILL BE ADEQUATE ONLY FOR VEGETATION CLEARING. THE DRAWINGS ARE NOT INTENDED TO GRAPHICALLY DEPICT ALL CONTROL MEASURES THAT WILL BE REQUIRED TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A.
2. DEVISE AND EMPLOY CONTROL MEASURES THROUGHOUT THE DURATION OF PROJECT, OVER ALL AREAS DISTURBED OR UNDISTURBED BY CONSTRUCTION, AS NECESSARY TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A.
3. DEVISE AND EMPLOY TEMPORARY CONTROL MEASURES AS NECESSARY TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A, WHILE ALLOWING WORK TO PROCEED IN AN EFFICIENT, COST EFFECTIVE MANNER.
4. DEVISE, EMPLOY AND MAINTAIN CONTROL MEASURES UNTIL SUCH TIME AS THE ENTIRE SITE IS PERMANENTLY STABILIZED BY ESTABLISHED VEGETATION, FINISH LANDSCAPE MATERIALS, PAVED SURFACES, AND/OR ROOF AREA.
5. ONCE THE SITE IS PERMANENTLY STABILIZED AND CERTIFIED AS SUCH BY ENGINEER, REMOVE TEMPORARY CONTROL MEASURES WHILE PROTECTING STABILIZED SURFACES.

1.02 SUBMITTALS

A. SUBMIT PRODUCT DATA, WARRANTY, AND TEST REPORTS AS INDICATED ON THE DRAWINGS.

B. DUE TO THE SIZE OF THE PROJECT AND MORE THAN 1 ACRE OF LAND DISTURBANCE, A CONSTRUCTION GENERAL PERMIT (CGP) IS REQUIRED TO BE FILED WITH THE US ENVIRONMENTAL PROTECTION AGENCY (EPA) UNDER ITS NON-POINT DISCHARGE ELIMINATION SYSTEM (NPDES) PROGRAM, CONSISTING OF AT MINIMUM, AN NPDES NOTICE OF INTENT AND A STORMWATER POLLUTION PREVENTION PLAN (SWPPP).

1.03 QUALITY ASSURANCE

A. COMPLY WITH GOVERNING CODES AND REGULATIONS. PROVIDE PRODUCTS FROM ACCEPTABLE MANUFACTURERS. USE EXPERIENCED INSTALLERS. DELIVER, HANDLE, AND STORE MATERIALS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.

B. CONFORM TO CONDITIONS OF APPROVAL ISSUED BY REGULATORY AGENCIES INCLUDING, BUT NOT NECESSARILY LIMITED TO, LOCAL PLANNING BOARD, CONSERVATION COMMISSION, BOARD OF SELECTMEN, BOARD OF HEALTH, PUBLIC WORKS / HIGHWAY DEPARTMENT, STATE ENVIRONMENTAL PROTECTION DEPARTMENT, AND U.S. GOVERNMENT, ENVIRONMENTAL PROTECTION AGENCY. WHERE CONDITIONS OF REGULATORY APPROVAL DIFFER FROM REQUIREMENTS CONTAINED HEREIN OR ON THE DRAWINGS, COMPLY WITH THE MORE STRINGENT REQUIREMENT.

PART 2 – PRODUCTS

2.01 MATERIALS

A. STRAW BALES: MACHINE BOUND WITH JUTE OR WIRE, APPROXIMATE SIZE EACH BALE 42" X 16" X 16".

B. SILT FENCE: NON-WOVEN, UV-RESISTANT, POLYPROPYLENE FABRIC, FLOW RATED AT 10 GPM/SF MINIMUM, GRAB TENSILE RATED AT 124 POUNDS MINIMUM, WITH INTEGRAL STAKE LOOPS, AND HARDWOOD STAKES. USE NO. 2130 BY AMOCO FABRICS & FIBERS, OR APPROVED EQUAL.

C. MULCH: ORGANICS INCLUDING HAY, PROCESSED PINE / HEMLOCK TWIGS AND NEEDLES.

D. SEED MIXES: PERENNIAL RYEGRASS, KENTUCKY BLUEGRASS, AND / OR FINE FESCUE, DISEASE RESISTANT. NON-MAINTAINED AREA OPTION – ANNUAL RYEGRASS COMBINED WITH MEDIUM RED CLOVER.

E. EXCELSIOR BLANKET: CURLED WOOD FIBER ON PHOTODEGRADABLE EXTRUDED PLASTIC MATRIX, 80% OF FIBERS 6-INCHES LONG OR LONGER, WEIGHT 0.975 POUNDS / SY, CONTAINING NO CHEMICAL ADDITIVES. USE CURLEX I BLANKET BY AMERICAN EXCELSIOR COMPANY, OR APPROVED EQUAL.

F. ROCK RIPRAP: SOUND, ANGULAR, 6-INCH MINUS PROCESSED ROCK, BLAST ROCK, OR TAILINGS.

G. CRUSHED STONE: SOUND, ANGULAR, 2-INCH MINUS PROCESSED CRUSHED STONE.

PART 3 – EXECUTION

3.01 THROUGHOUT CONSTRUCTION

A. DEVISE WORK SEQUENCE SO AS TO LIMIT DRAINAGE AREA THAT IS TRIBUTARY TO DISTURBED AREAS. DEVISE, EMPLOY, AND MAINTAIN CONTROL MEASURES SUCH AS DIVERSION CHANNELS AND BERMS, STRATEGICALLY LOCATED STOCKPILES, AND SEDIMENT BASINS TO SUBDIVIDE DRAINAGE AREAS INTO SMALL, MANAGEABLE SUBAREAS, THEREBY MINIMIZING RUNOFF AND THE POTENTIAL FOR EROSION.

B. MAINTAIN BARRIER AT LIMIT OF WORK AND PROTECT EXISTING VEGETATION / FACILITIES OUTSIDE OF LIMIT OF WORK.

C. MAINTAIN SPARE MATERIAL STOCKPILES FOR IMMEDIATE EMPLOYMENT / REPAIR / EXPANSION OF CONTROL MEASURES. AT A MINIMUM, SUCH MATERIALS SHALL INCLUDE STRAW BALES, SILT FENCE AND STAKES, AND CRUSHED STONE.

D. INSPECT AND MAINTAIN EFFECTIVENESS OF CONTROL MEASURES BY REPAIRING AS NECESSARY TO ENSURE INTENDED FUNCTION, BY SUPPLEMENTING AS NECESSARY FOR ADEQUATE EXTENT; BY REMOVING TRAPPED PRODUCTS OF EROSION AS NECESSARY TO MAINTAIN EFFECTIVE TRAP VOLUME.

E. LIMIT EXTENT OF WORK AREA SO THAT ALL DISTURBED AREAS CAN BE STABILIZED WITH CONTROL MEASURES WITHIN A 24-HOUR PERIOD. IN NO EVENT SHALL A GROUND SURFACE, SLOPE OR STOCKPILE BE LEFT DENUDED FOR MORE THAN 14 DAYS WITHOUT APPLICATION OF TEMPORARY OR PERMANENT SURFACE STABILIZATION PRACTICES.

F. INSTALL CONTROL MEASURES AS SOON AS PRACTICABLE AFTER EACH MANAGEABLE PORTION OF EARTHWORK IS COMPLETE. EMPLOY TEMPORARY MEASURES AS NECESSARY TO STABILIZE DISTURBED AREAS, EVEN WHERE SUBSEQUENT CONSTRUCTION OPERATIONS MAY REQUIRE RE-DISTURBANCE.

G. WHEN INTENSE RAINFALL IS EXPECTED, CONSIDER, DEVISE, AND EMPLOY REINFORCING CONTROL MEASURES PRIOR TO THE RAINFALL EVENT TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A. IF NECESSARY, EMPLOY TEMPORARY CONTROL MEASURES ON MATERIAL STOCKPILES TO COUNTERACT POTENTIAL SEDIMENT TRANSPORT DURING INTENSE RAINFALL.

H. WHEN VEHICLE REFUELING IS REQUIRED ON SITE, CONDUCT REFUELING OPERATIONS OUTSIDE OF ENVIRONMENTALLY SENSITIVE AREAS.

I. PROPERLY DISPOSE OF DEBRIS, SOLID WASTE, TRASH, AND CONSTRUCTION WASTE / BYPRODUCTS OFF SITE.

J. SWEEP ON-SITE PAVED AREAS AND OFF-SITE STREETS AS NECESSARY TO PREVENT SILT AND DEBRIS ORIGINATING ON SITE FROM ENTERING CLOSED DRAINAGE SYSTEMS AND / OR ENVIRONMENTALLY SENSITIVE AREAS.

3.02 SITE PREPARATION AND ACCESS

A. WALK SITE AND IDENTIFY LOCATIONS OF LIMIT OF WORK AND ENVIRONMENTALLY SENSITIVE AREAS. ESTABLISH CONSTRUCTION STAGING AREA, LOCATED BEYOND ENVIRONMENTALLY SENSITIVE AREAS.

B. INSTALL CONTROL MEASURES AS SHOWN ON THE DRAWINGS, INCLUDING THOSE DEFINING THE LIMIT OF WORK.

C. LIMIT VEHICULAR TRAFFIC TO AND FROM SITE TO MINIMIZE TRANSPORT OF SEDIMENT.

3.03 CLEARING, GRUBBING, AND STRIPPING

A. SCHEDULE GRUBBING AND STRIPPING TO OCCUR IMMEDIATELY PRIOR TO EARTH DISTURBANCE. DEPENDING ON SITE AREA, CONSIDER MULTIPLE GRUBBING PHASES, SEQUENCED TO TAKE ADVANTAGE OF THE EROSION PREVENTION POTENTIAL OF EXISTING VEGETATIVE COVER.

B. MINIMIZE THE AREA OF EXISTING VEGETATION REMOVED WHEREVER POSSIBLE.

C. LOCATE AND SIZE STOCKPILES TO MINIMIZE EROSION POTENTIAL, TAKING ADVANTAGE OF TERRAIN SLOPE AND ASPECT, WHERE APPROPRIATE.

D. PROTECT VEGETATION, INCLUDING ROOT SYSTEMS, BEYOND LIMIT OF CLEARING.

E. PROCESS TIMBER, STUMPS, SLASH, AND BRUSH SO AS TO PROTECT ENVIRONMENTALLY SENSITIVE AREAS AND INSTALLED CONTROL MEASURES. PROPERLY DISPOSE OF EXCESS OFF SITE. BURIAL OF STUMPS ON SITE IS PROHIBITED.

3.04 EXCAVATION FOR BUILDING FOUNDATIONS AND UTILITIES

A. DEVISE AND INSTALL CONTROL MEASURES ADEQUATE TO HANDLE DISCHARGES AND TRAP SEDIMENT FROM FOOTING SUMP AND WELL POINT PUMPS PRIOR TO EXCAVATION.

B. ARMOR SUMP PUMP DISCHARGE LOCATIONS TO PREVENT EROSION AT POINT OF DISCHARGE AND AREAS DOWNSTREAM.

C. IF FOUNDATION EXCAVATIONS GRADE TO DAYLIGHT ON THE LOW SIDE, DEVISE AND INSTALL CONTROL MEASURES TO HANDLE SURFACE AND GROUNDWATER FLOW FROM EXCAVATION LOW POINT.

D. STOCKPILE EXCAVATED MATERIALS TO BAFFLE OVERLAND RUNOFF, AVOIDING THE CREATION OF LENGTHY PATHS OF CONCENTRATED RUNOFF.

E. BACKFILL UTILITY TRENCHES AS SOON AS PRACTICABLE TO PREVENT FLOODING, SLOUGHING, POTENTIAL OVERFLOW, AND REPETITIVE EARTH DISTURBANCE.

3.05 SITE GRADING

A. WHERE APPLICABLE, FOLLOW EXCAVATION AND FILL PRACTICES SHOWN ON DRAWINGS TO LOCALIZE AND MINIMIZE EROSION.

B. MONITOR SEDIMENT VOLUME IN TEMPORARY SEDIMENT BASINS AND AT DIVERSION BERMS AND CHECK DAMS. IN ALL AREAS EXCEPT THOSE THAT DO NOT PRESENT POTENTIAL PROBLEMS WITH REGARD TO FUTURE SOIL STABILITY, DRAINAGE, OR BEARING CAPACITY, REMOVE AND PROPERLY DISPOSE OF TRAPPED SEDIMENT BEFORE BRINGING SITE TO FINAL SUBGRADE.

3.06 STORMWATER MANAGEMENT SYSTEM

A. THE STORMWATER MANAGEMENT SYSTEM INCLUDES, BUT IS NOT NECESSARILY LIMITED TO, ALL PERMANENT DETENTION / RETENTION BASINS, DISCHARGE STRUCTURES / WEIRS, CULVERTS, OPEN CHANNELS, CURBS, GUTTERS, PAVED SWALES, CATCH BASINS, DRAIN MANHOLES, DRAINAGE PIPES, ROOF DRAIN MANIFOLDS, WATER QUALITY SWALES, SEPARATORS, AND SIMILAR STORMWATER RUNOFF CONVEYANCE, TREATMENT, AND STORAGE FACILITIES.

B. INSTALL STORMWATER MANAGEMENT SYSTEM COMPONENTS STARTING AT THE DOWNSTREAM END AND PROCEED UPSTREAM. WHERE POSSIBLE, COMPLETE INSTALLATION OF PERMANENT DETENTION / RETENTION BASINS PRIOR TO BEGINNING WORK ON UPSTREAM SYSTEM COMPONENTS.

C. INSTALL CONTROL MEASURES AT FINISHED UPSTREAM AND DOWNSTREAM PIPE ENDS AS SOON AS POSSIBLE AFTER COMPLETION OF PIPE RUN. SUCH MEASURES INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, RIPRAP, CHECK DAMS, STRAW BALE / SILT FENCE BARRIERS, AND VELOCITY DISSIPATORS.

D. AT THE END OF EACH DAY OR WHEN RAINFALL IS EXPECTED, PLUG UPSTREAM END OF PIPES / DAM OPEN CHANNELS OR OTHERWISE REDIRECT POTENTIAL RUNOFF AND PREVENT FLOW FROM ENTERING PARTIALLY COMPLETED SYSTEM / SYSTEM COMPONENTS.

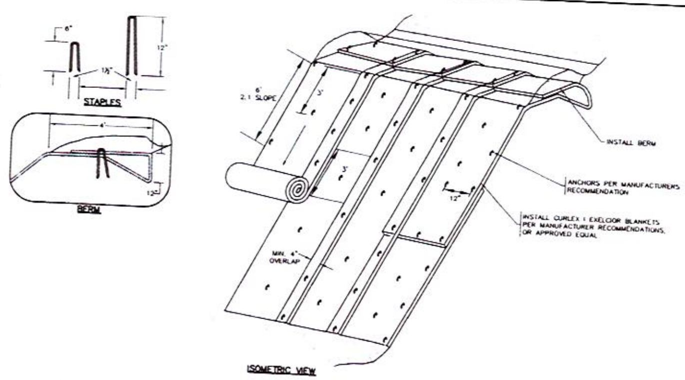
E. WHERE PORTIONS OF A NEW SYSTEM, ESPECIALLY FOR INFILTRATION BASINS, ARE TO BE ACTIVATED PRIOR TO COMPLETION OF THE ENTIRE SYSTEM, EMPLOY CONTROL MEASURES TO PREVENT SILT AND DEBRIS FROM ENTERING THE SYSTEM. EMPLOY SILT SACKS OR FABRIC ON CATCH BASIN INLETS, AND PIPE AND CULVERT OPENINGS. EMPLOY CHECK DAMS AND TEMPORARY SEDIMENT BASINS UPSTREAM OF AND ALONG OPEN CHANNELS, SWALES, AND DITCHES TO TRAP SEDIMENT UPGRADIENT OF ENVIRONMENTALLY SENSITIVE AREAS.

F. REMOVE TRAPPED SEDIMENT AND DEBRIS FROM ALL SYSTEM COMPONENTS AFTER COMPLETION OF INSTALLATION, AND AGAIN AFTER THE ENTIRE SITE IS PERMANENTLY STABILIZED BY ESTABLISHED VEGETATION, FINISH LANDSCAPE MATERIALS, PAVED SURFACES, AND/OR ROOF AREA. REMOVE TRAPPED SEDIMENT AND DEBRIS FROM DETENTION / RETENTION BASIN BOTTOMS SO THAT FINISH BOTTOM MATERIALS / INFILTRATION FUNCTION CONFORM TO DESIGN.

3.07 LANDSCAPING

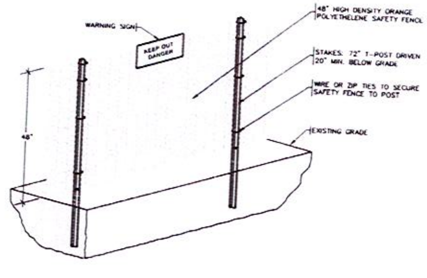
A. COMPLETE LANDSCAPING AS SOON AS POSSIBLE AFTER COMPLETION OF FINAL SUBGRADE.

B. IMMEDIATELY AFTER PLACEMENT OF PERMANENT LOAM OR TOPSOIL TO FINISHED GRADE, PERMANENTLY STABILIZE WITH CONTROL MEASURES INCLUDING, BUT NOT NECESSARILY LIMITED TO, SEED MIX, MULCH, AND / OR EROSION CONTROL BLANKETS.



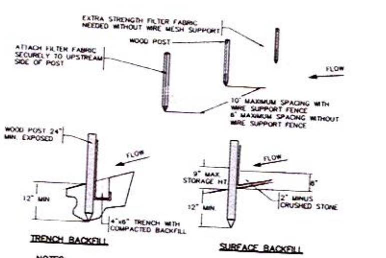
NOTES:
[1] SLOPE SURFACE SHALL BE FREE OF ROCK, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT
[2] APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS
[3] LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH
[4] MATS/BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE
[5] TAMP SOIL OVER MAT/BLANKET

TURF REINFORCEMENT MAT
NOT TO SCALE



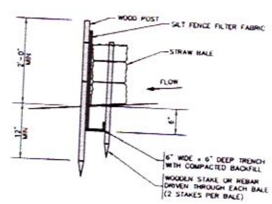
[1] ALL ACTIVE CONSTRUCTION AREAS SHALL BE PROTECTED AS PER PLAN
[2] SAFETY FENCE SHOULD BE FASTENED SECURELY TO THE T-POSTS
[3] THE FENCING MUST REMAIN IN PLACE DURING ALL PHASES OF CONSTRUCTION; ANY CHANGE OF THE PROTECTIVE FENCING MUST BE APPROVED.
[4] "DANGER KEEP OUT" SIGNS TO BE SPACED AT 100 FT INTERVALS.

ORANGE CONSTRUCTION SAFETY FENCE
TYPICAL CROSS SECTION
NOT TO SCALE



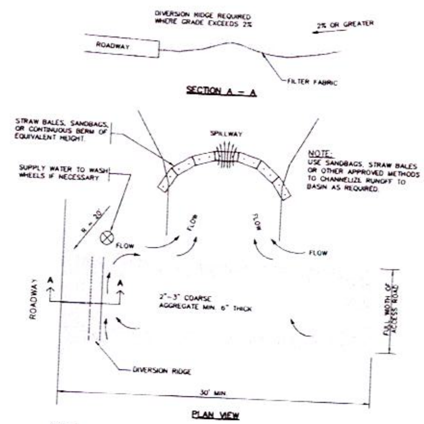
NOTES:
[1] SILT FENCE SHALL BE PLACED ALONG CONTOUR TO MAXIMIZE PONDING EFFICIENCY.
[2] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
[3] REMOVED SEDIMENT SHALL BE DEPOSITED TO A NON-SENSITIVE UPLAND AREA.

SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE



NOTES:
[1] BALES SHALL BUTT TOGETHER TO FORM A CONTINUOUS BARRIER.
[2] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
[3] TRAPPED SEDIMENT SHALL BE REMOVED TO A NON-SENSITIVE UPLAND AREA.

STRAW BALE / SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE

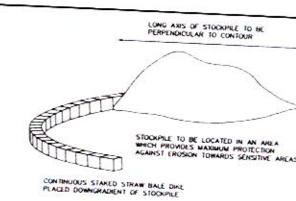


NOTES:
1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.

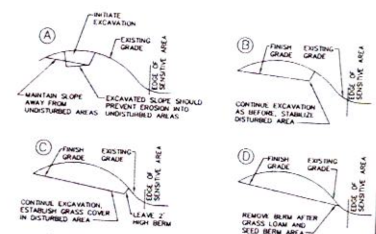
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.

3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

CONSTRUCTION ENTRANCE
NOT TO SCALE



TEMPORARY STOCKPILE
ISOMETRIC VIEW
NOT TO SCALE



EXCAVATION PROCEDURE
TYPICAL CROSS SECTION
NOT TO SCALE

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COMMONWEALTH OF MASSACHUSETTS NICHOLAS M. PAULING CIVIL No. 47114 REGISTERED PROFESSIONAL ENGINEER

4/8/2021

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SOLAR PHOTOVOLTAIC PROJECT

EROSION AND SEDIMENT CONTROL DETAILS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C3.4
CHK. BY: KFB			

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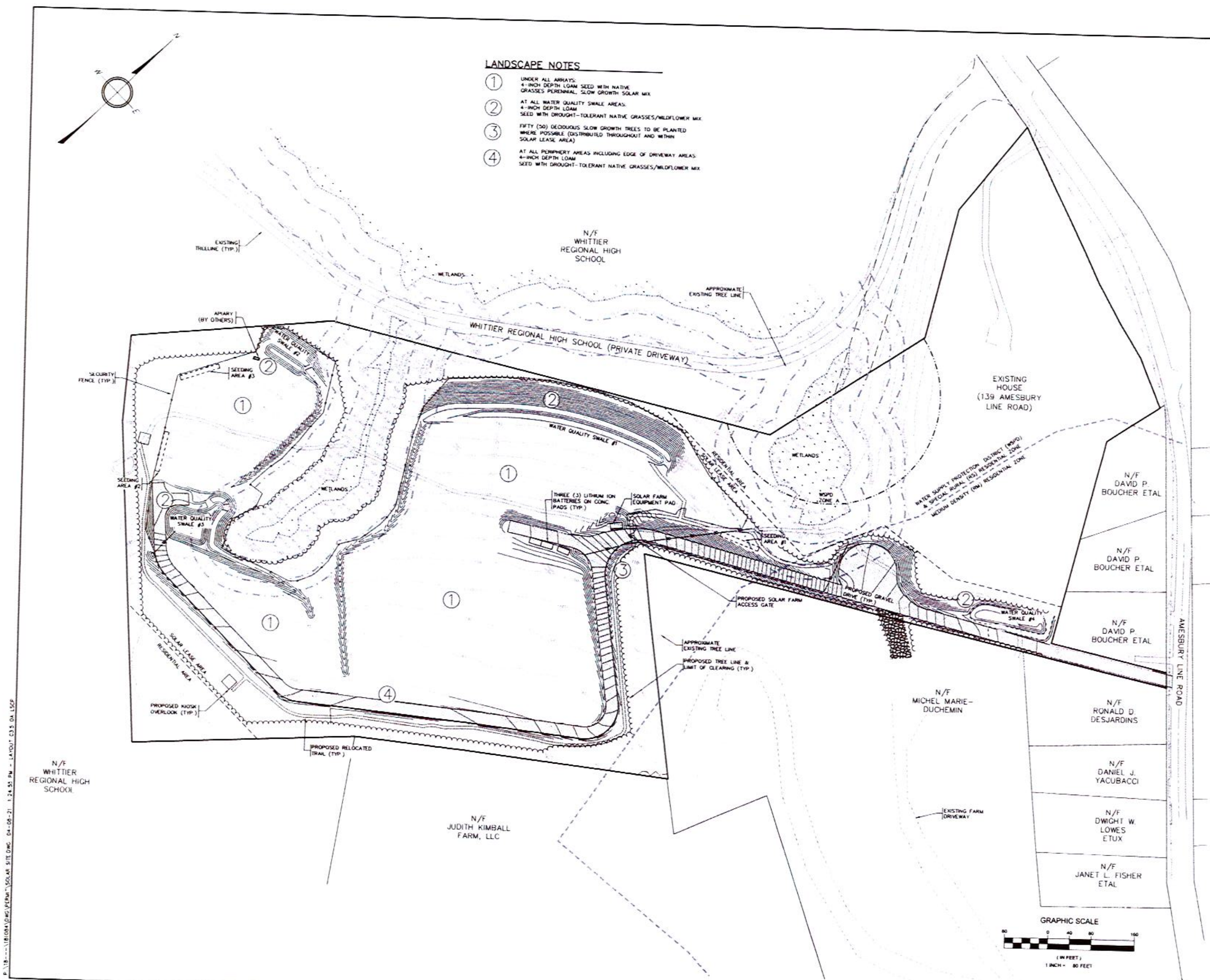
LANDSCAPE NOTES

1. UNDER ALL ARRAYS:
4-INCH DEPTH LOAM SEED WITH NATIVE
GRASSES PERENNIAL, SLOW GROWTH SOLAR MIX
2. AT ALL WATER QUALITY SWALE AREAS:
4-INCH DEPTH LOAM
SEED WITH DROUGHT-TOLERANT NATIVE GRASSES/WILDFLOWER MIX
3. FIFTY (50) DECIDUOUS SLOW GROWTH TREES TO BE PLANTED
WHERE POSSIBLE (DISTRIBUTED THROUGHOUT AND WITHIN
SOLAR LEASE AREA)
4. AT ALL PERIPHERY AREAS INCLUDING EDGE OF DRIVEWAY AREAS:
4-INCH DEPTH LOAM
SEED WITH DROUGHT-TOLERANT NATIVE GRASSES/WILDFLOWER MIX



LEGEND

EXISTING		PROPOSED
	ELEVATION CONTOUR	100
	SPOT GRADE	100.0 FG
	PROPERTY LINE	
	WETLAND DELINEATION	
	WETLAND BUFFER ZONE	
	SHORELINE	
	EPHEMERAL POOL DELINEATION	
	EPHEMERAL POOK BUFFER ZONE	
	100-YEAR FLOODPLAIN LIMIT	
	EDGE OF PAVEMENT	
	CAPE COD BERM CURBING	
	GRANITE CURBING	
	GRAVEL/DIRT ROAD	
	STOCKADE FENCE	
	STONE WALL	
	WATER MAIN	W
	WATER SERVICE	WS
	FIRE SERVICE	FS
	WATER VALVE	WV
	FIRE HYDRANT	
	FORCE MAIN	FM
	GRAVITY SEWER LINE	SS
	SEWER MANHOLE	SMH
	GAS LINE	
	GAS SERVICE	GS
	GAS VALVE	
	BURIED POWER LINE	E
	OVERHEAD POWER LINE	
	UTILITY POLE	
	GUY WIRE	
	ELECTRIC BOX	E
	STORM DRAIN	SD
	UNDERDRAIN	UD
	ROOF DRAIN	RD
	FOUNDATION DRAIN	FD
	CATCH BASIN	
	DRAIN MANHOLE	
	DEEP SOIL OBSERVATION HOLE	
	MAILBOX	
	SITE LUMINAIRE	
	SIGN	
	ELEVATION BENCHMARK	
	SURFACE RUNOFF DIRECTION	
	STONE BOUND	
	DRILL HOLE	
	IRON ROD	

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

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COMMONWEALTH OF MASSACHUSETTS
NICHOLAS M. PAULING
CIVIL
No. 47114
REGISTERED PROFESSIONAL ENGINEER

4/8/2021

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SOLAR PHOTOVOLTAIC PROJECT

LANDSCAPING PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

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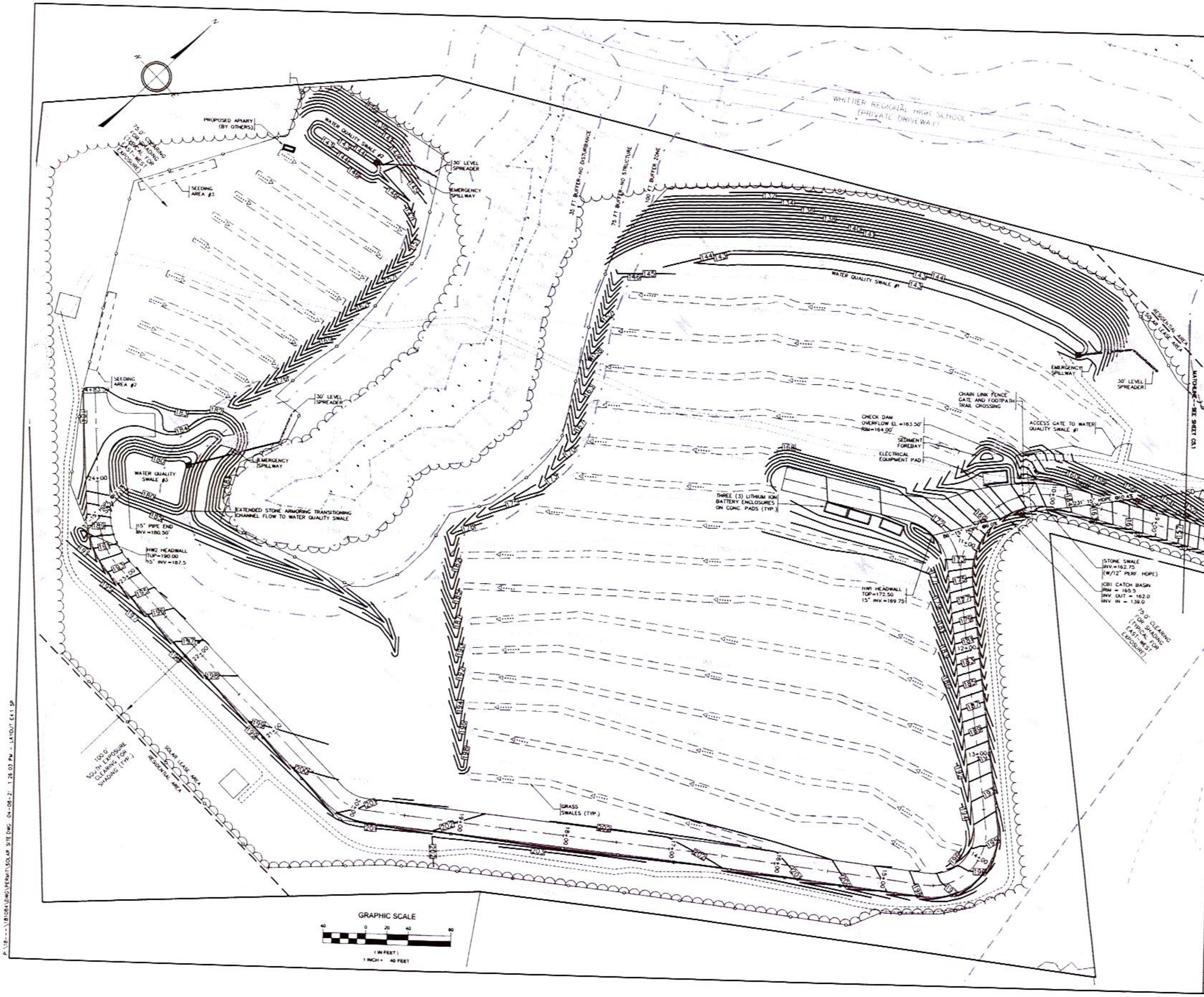

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COMMONWEALTH OF MASSACHUSETTS NICHOLAS M PAULING CIVIL No. 47114 REGISTERED PROFESSIONAL ENGINEER

Nicholas Pauling
4/8/2021

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SITE PLAN

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HAVERHILL, MA

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SUMMERVILLE, SC 29483

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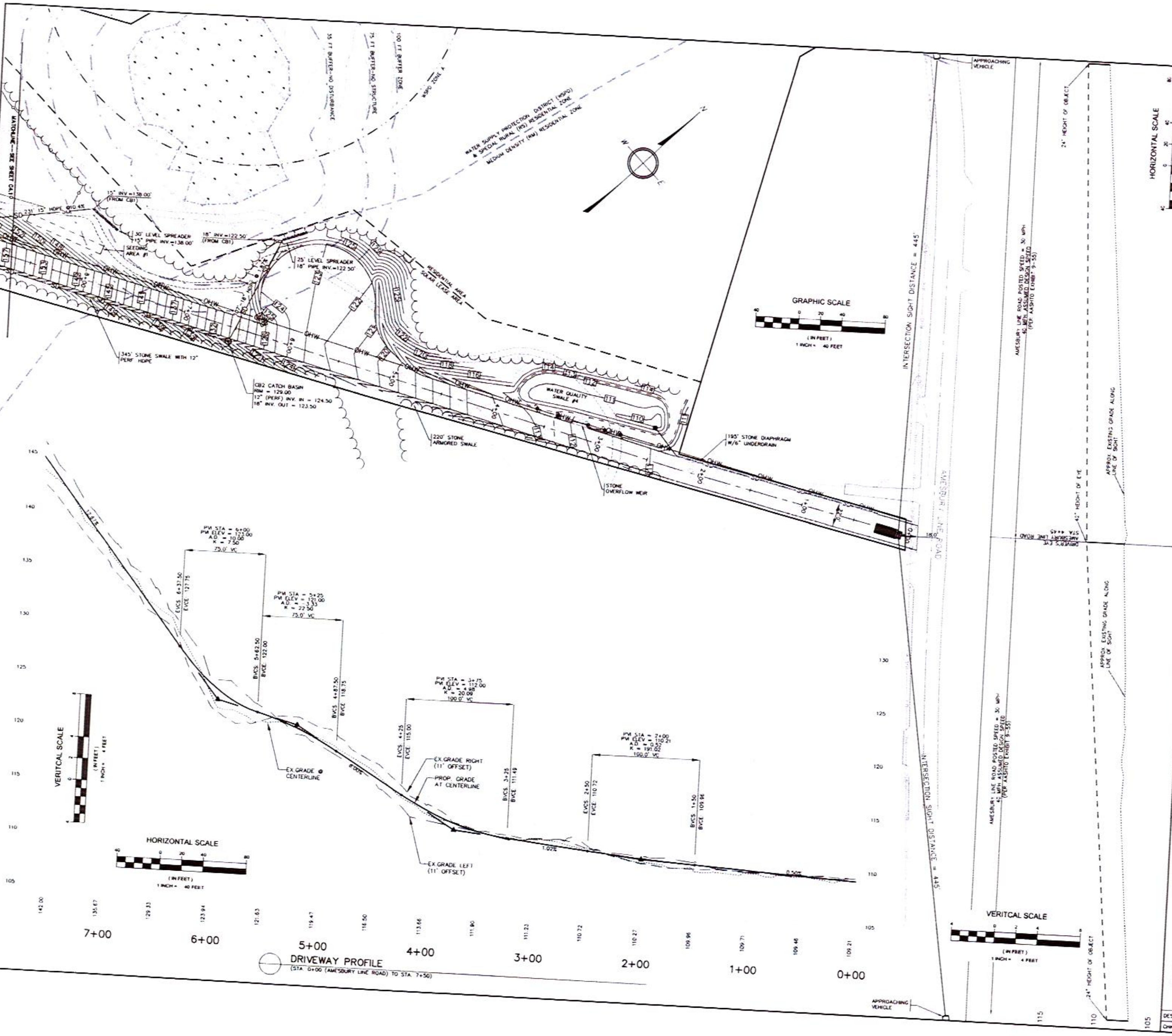

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NICHOLAS M PAULING CIVIL No. 47114
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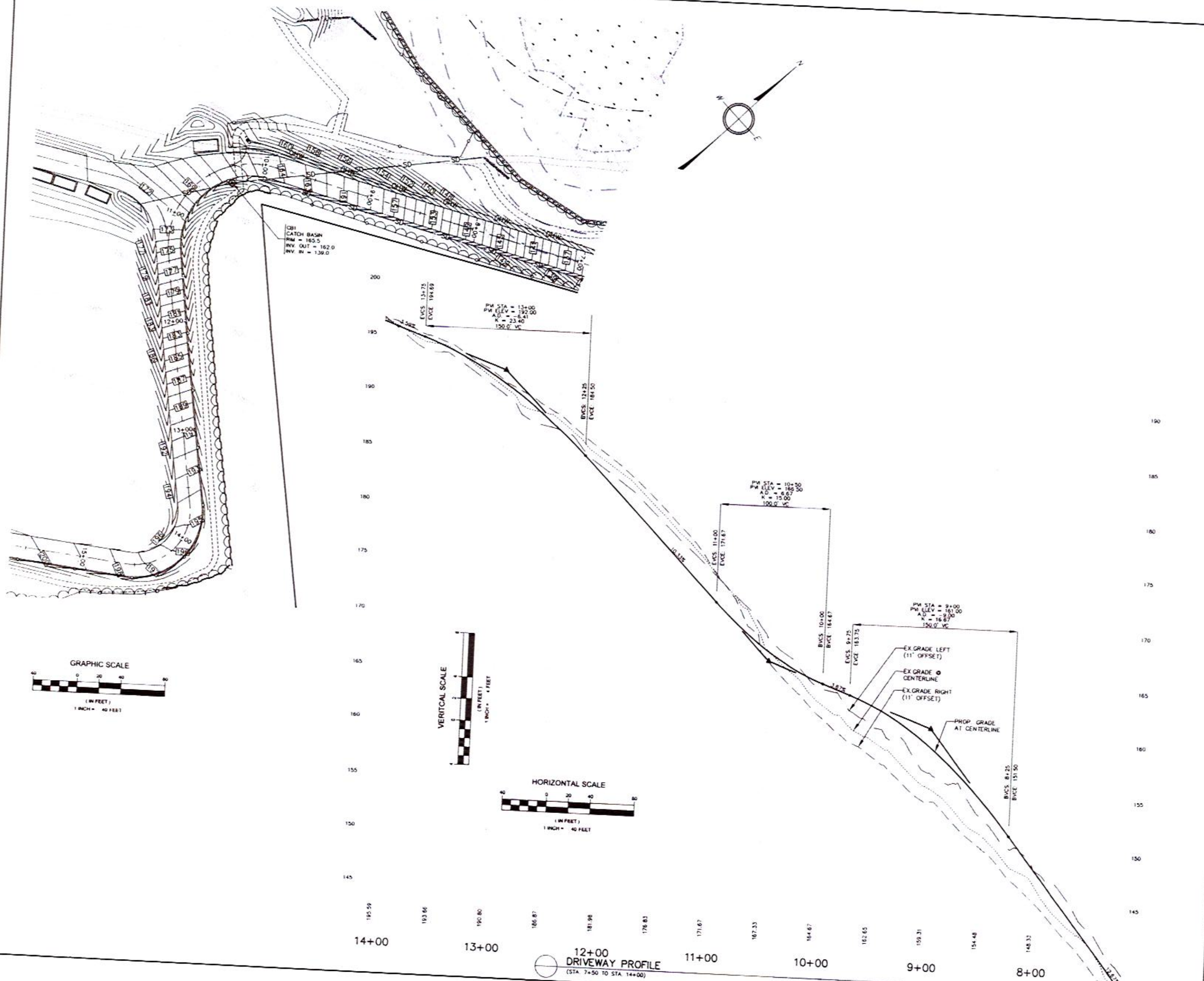

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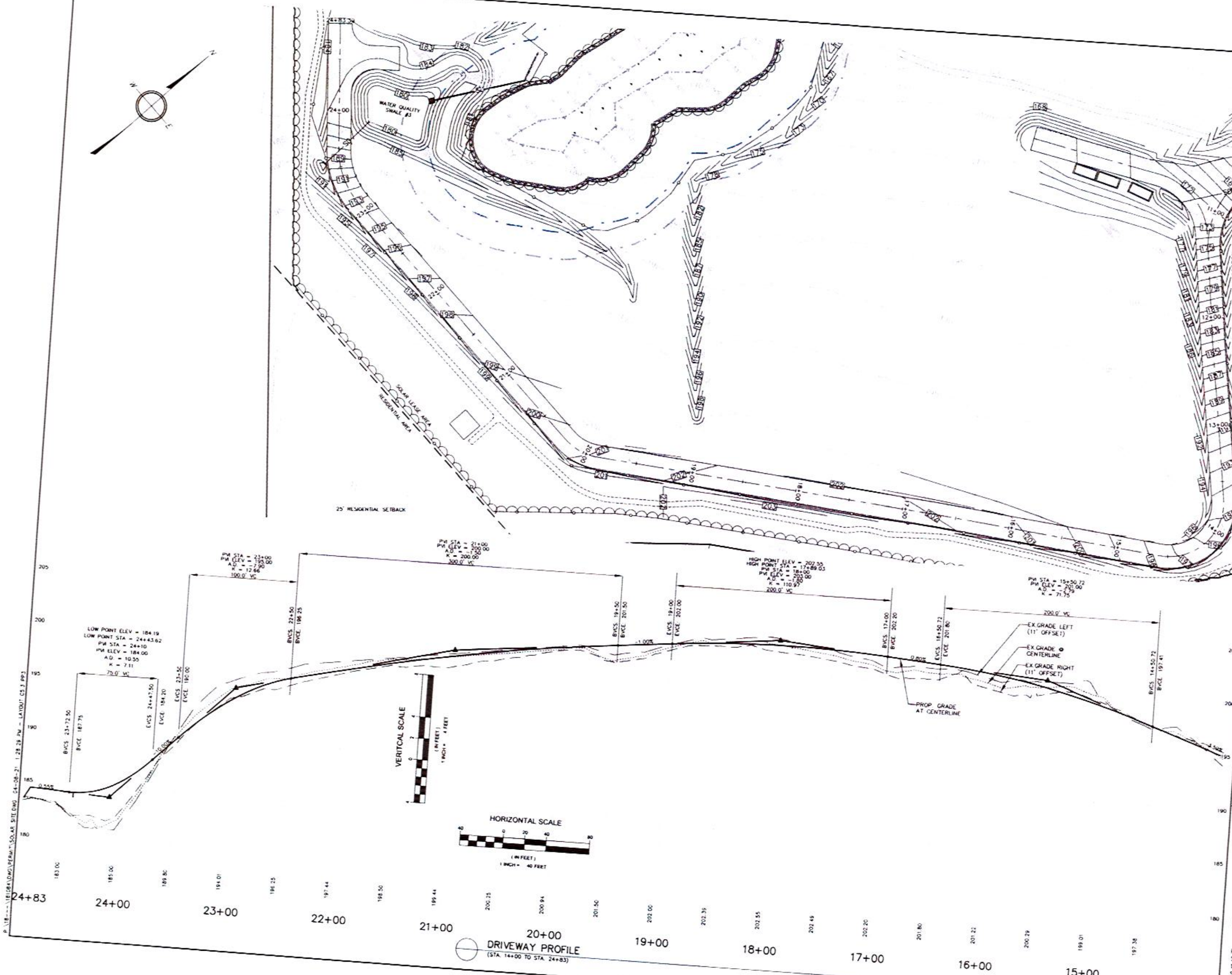

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HAVERHILL, MA

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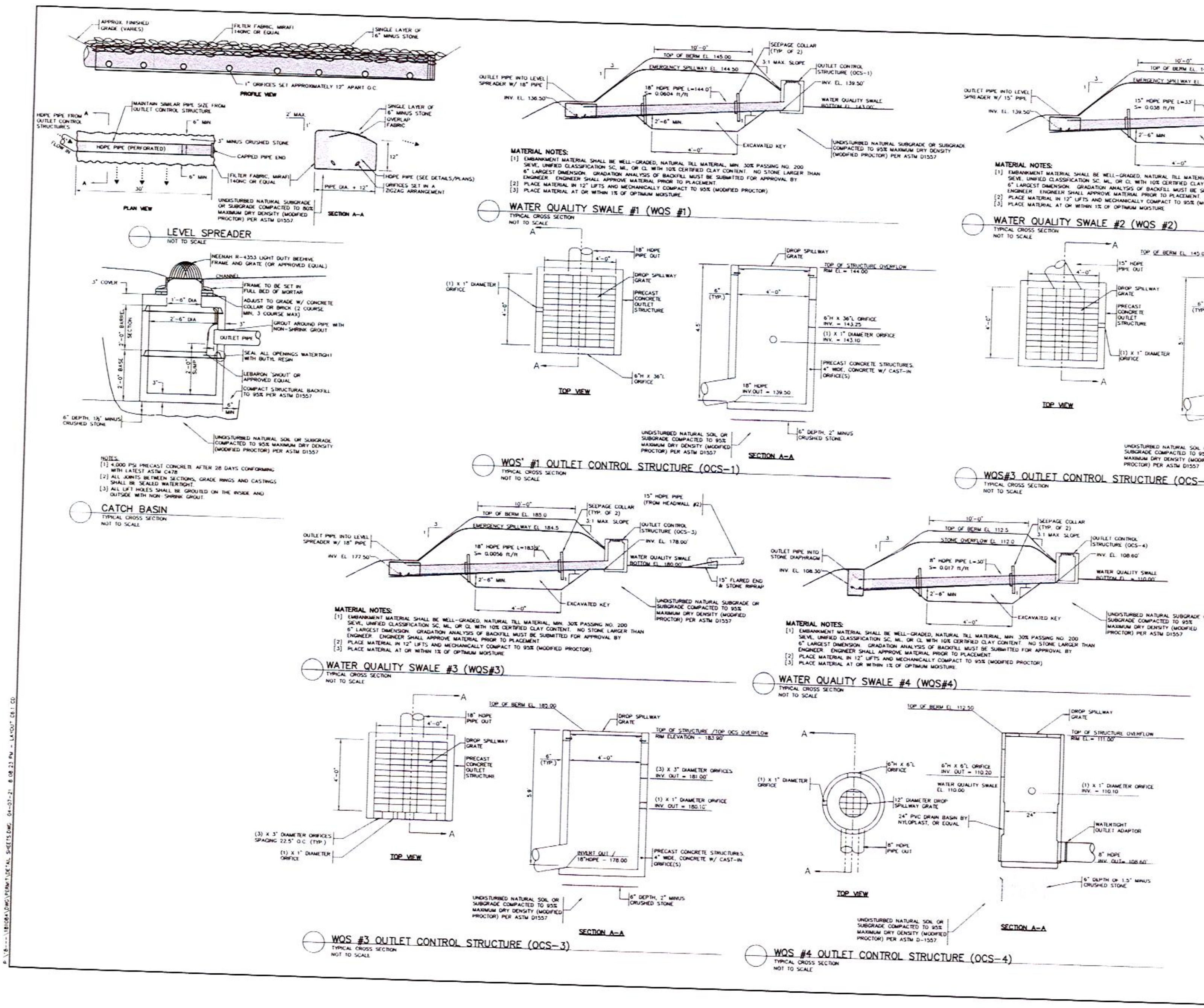

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SOLAR PHOTOVOLTAIC PROJECT

CONSTRUCTION DETAILS

HAVERHILL SOLAR
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HAVERHILL, MA

PREPARED FOR:
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1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

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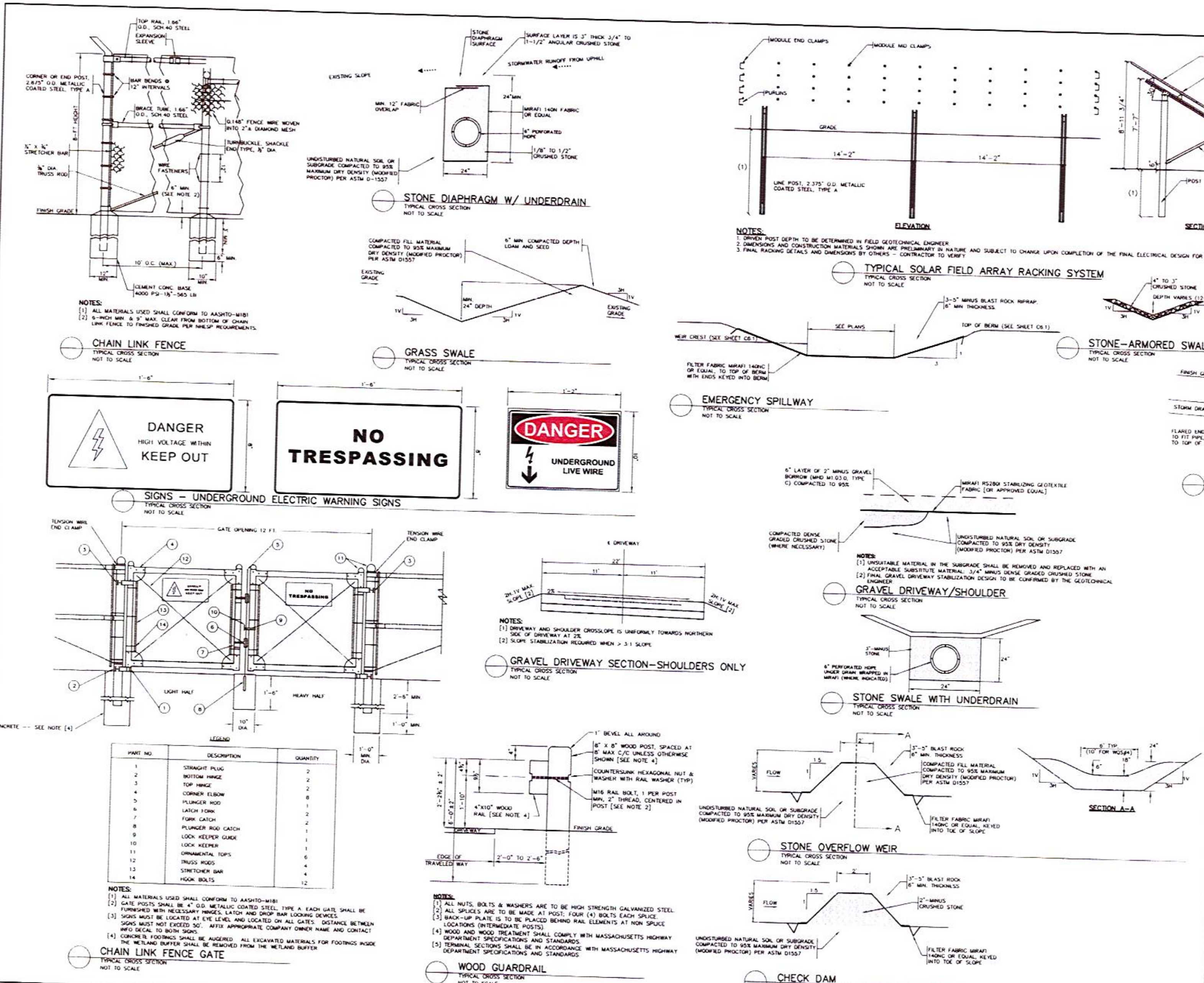

LEGEND

PART NO.	DESCRIPTION	QUANTITY
1	STRAIGHT PLUG	2
2	BOTTOM HINGE	2
3	TOP HINGE	2
4	CORNER ELBOW	8
5	PLUNGER ROD	1
6	LATCH FORK	2
7	FORK CATCH	2
8	PLUNGER ROD CATCH	1
9	LOCK KEEPER GUIDE	1
10	LOCK KEEPER	1
11	ORNAMENTAL TOPS	6
12	TRUSS RODS	4
13	STRETCHER BAR	4
14	HOOK BOLTS	12

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SOLAR PHOTOVOLTAIC PROJECT

CONSTRUCTION DETAILS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C6.2
CHK. BY: KFB			

HAVERHILL SOLAR FARM
139 AMESBURY LINE ROAD

SOLAR SYSTEM COMPONENTS
-CANADIAN SOLAR MODULES
-DCE SOLAR RACKING
-SAMSUNG LITHIUM ION BATTERIES
-SUNGROW BATTERY HOUSING
-ANSUL FM200 CLEAN FIRE SUPPRESSION

NEW

Andrew to Update

CanadianSolar

BiHiKu6 Mono

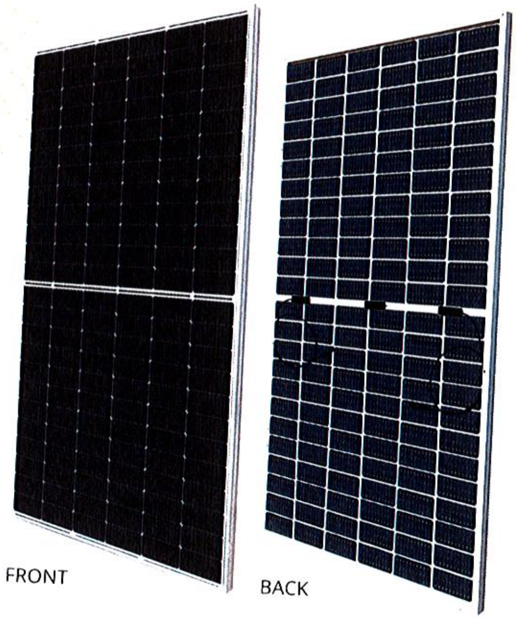
BIFACIAL MONO PERC

520 W ~ 540 W

UP TO 30% MORE POWER FROM THE BACK SIDE

CS6W-520|525|530|535|540MB-AG

Dimensions: 2266 × 1135 × 35 mm (89.2 × 44.7 × 1.38 in)
Weight: 32.4 kg (71.4 lbs)
Max. System Voltage: 1500 V (IEC/UL) or 1000 V (IEC/UL)



MORE POWER

540 W

Module power up to 540 W
Module efficiency up to 21.0 %

Up to 12.3 % lower LCOE
Up to 5.2 % lower system cost

Comprehensive LID / LeTID mitigation technology, up to 50% lower degradation

Compatible with mainstream trackers, cost effective product for utility power plant

Better shading tolerance

MORE RELIABLE

Minimizes micro-crack impacts

Heavy snow load up to 5400 Pa, wind load up to 2400 Pa*

* For detailed information, please refer to the Installation Manual

12 Years — **Enhanced Product Warranty on Materials and Workmanship***

30 Years — **Linear Power Performance Warranty***

1st year power degradation no more than 2%
Subsequent annual power degradation no more than 0.45%

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

* As there are different certification requirements in different markets, please contact your local Canadian Solar sales representative for the specific certificates applicable to the products in the region in which the products are to be used

CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 43 GW deployed around the world since 2001.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

DCE SOLAR

Elevating the Future for Solar | Made in America

Contour™ DB-II

ASSEMBLY MANUAL

ISSUED: JULY 10TH, 2019 **REV-G**

Inspection Operation and Maintenance Procedure

Inspections During the System Warranty Period

Snow Removal

- Substantial snow accumulation that completely fills the gap between front of the panels and ground must be removed immediately to prevent excessive snow drift and ice dam formation. DCE Solar should be notified immediately of any structural issues and the issues should be documented with photos.

The following inspections should be performed at a minimum of every year of the warranty period.

Check Connections

- Visually inspect all bolted connections and verify that connections have not visually loosened (torque marks should be inline). Also look for any instance of slippage or part movement.
- Check the torque on 10% of the bolted connections to 80% of the torque value given in the installation manual. If 10% of the of the inspected hardware does not meet the 80% torque value, perform a site-wide inspection and retorque all similar connections.
- If any of the connections require re-torqueing, reinspect in 6 and notify DCE Solar. DCE solar should be notified on any instances where such corrective action is required.

Inspect Foundations

- Check for ground erosion and settlement around the foundation of the system and correct any site issues where excessive erosion, standing water, or other factors that could inhibit foundation performance.
- Ground screw system; check the height of the inside tube connected to the N/S beam to ensure no vertical moved has occurred.

Corrosion

Perform a visual inspection for evidence of corrosion on all structural components. Excessive corrosion is defined as:

- Any instance where red rust covers more than 5% of the total surface area
- Any localized or pitting corrosion where the structural performance of a component may be impeded.

Note: *It is common to observe white rust on galvanized components, this does not present any structural concern and requires no corrective action. It is common on pre-galvanized materials to observe red rust on cut edges or holes. This is typical and does not present any structural concern and requires no corrective action.*

Any component where the structural integrity has been compromised must be replaced immediately. Where the integrity of structural components has not been impacted, the galvanized coating should be repaired in accordance with the ASTM A780 Standard.

Contact

If any corrective action is required on a site, or if there are any questions or causes for concern from the site inspection, contact DCE Solar at 704 659-7477 or info@dcesolar.com.

SAMSUNG SDI

Energy Storage System
Battery Business

Global Network

KOREA(HQ)	150-20 Gongse-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17084, Korea TEL +82-31-210-8209 **E-mail** energy.storage@samsung.com
GERMANY	Reichenbachstrasse 2, 85737 Ismaning, Germany TEL +49-89-9292-7799(19) **E-mail** sintaek.yim@samsung.com
USA	3655 North 1st Street, San Jose, CA 95134, USA TEL +1-408-544-4491 **E-mail** hk1.kim@samsung.com
CHINA	No.788, Mingchuan Rd. Boyan Science & Technology Park,Hefei State Hi-tech Zone,P.R.China TEL +86-551-6532-7500 **E-mail** hgleo.ryu@samsung.com
JAPAN	(108-0075) Shinagawa Grand Central Tower 9F, 2-16-4, Konan, Minato-ku, Tokyo, Japan TEL +81-3-6369-6414 **E-mail** m.goto@samsung.com
TAIWAN	7F-1, No.399, Ruiguang Rd., Neihu Dist., Taipei City 114, Taiwan TEL +886-2-8178-5974 **E-mail** allen01.chen@samsung.com

Feb. 2019

www.samsungsdi.com

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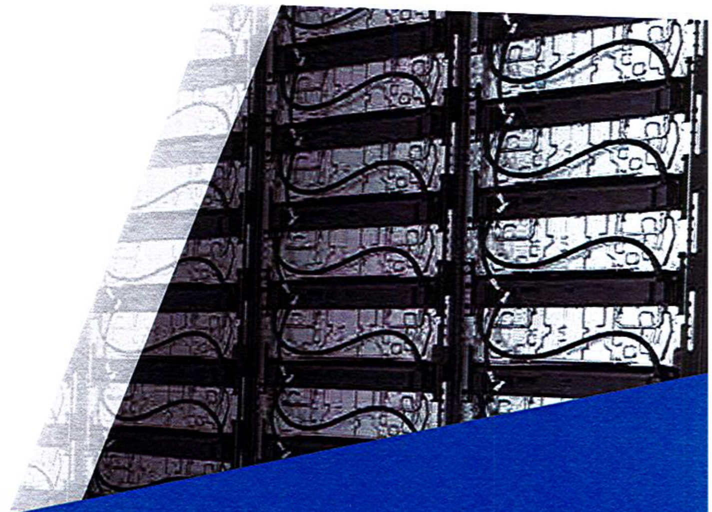


ESS Batteries by Samsung SDI

Top Safety & Reliability Solutions

SAMSUNG SDI

SAMSUNG SDI

Creative Energy
& Materials Solution Leader

Samsung SDI is leading the change of a new era with lithium-ion batteries.

Through our constant innovation towards excellence, we led with the technological superiority of our innovative IT devices and expanded into electric cars which have now become reality. In addition, we are contributing to the expansion of an eco-friendly environment by the deployment of batteries for energy storage.

We are all dreaming of a better future with BoT (Battery of Things) in which Samsung SDI will provide solutions for the world.

1970 — Established Samsung SDI

2000 — Began Lithium-ion Battery Business

2008 — Expanded Business into Automotives

2010 — Expanded Business into Energy Storage

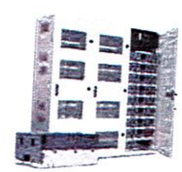
Powering Tomorrow,
Samsung SDI Battery Solution for Energy Storage

Samsung SDI's technology supplies eco-friendly energy solutions for the present and the future.

We provide safe, reliable and long-lasting performance with our Energy Storage solutions. ESS projects are deployed using Samsung SDI's battery solutions optimized for a range from residential to utility-scale projects.

Utility & Commercial Battery Platform

Optimized Battery Platforms Based on High-Density Design Technology



UPS Lithium Ion Solution

Proven High-Voltage LIB Solutions Compatible with Premium UPS

Residential & Telecom

Scalable Standard Battery Pack for Customized ESS

Why Samsung SDI

Samsung SDI optimizes battery systems with advanced cell technology.

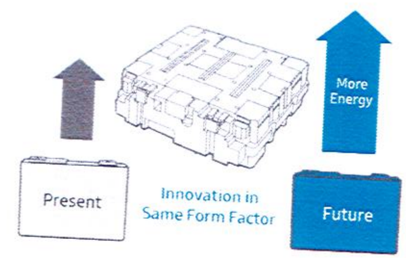
Safety First

Multi-Layered
Protection

Safety first is Samsung SDI priority. Prismatic cell has multi-layered protection at the cell level resulting in best in class safety. In addition, the aluminum exterior has excellent thermal conductivity and cooling performance, and it releases high temperature safely and efficiently from the inside to the outside.

Sustainable Design

Easy to Upgrade
Capacity without
Design Change



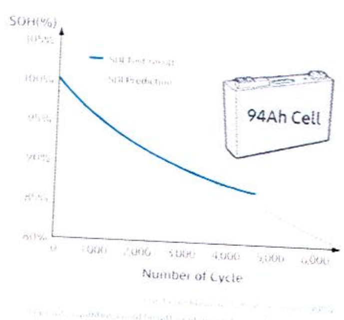
We are continuously innovating to increase the energy density while maintaining the same form factor and cell dimensions, thus facilitating future upgrades to higher capacity, higher energy density, ESS with no change to pack design.

Long Cycle Life

Industry Leading Cycle Life Performance

6,000 Cycles

@continuous 1C/1C, SOH 80%



Samsung SDI ESS leverages our manufacturing experience in IT and automotive battery cells resulting in superior and adaptive technology. Samsung SDI ESS is recognized as the industry leader in the market, providing our customers with the safest and long lasting batteries.

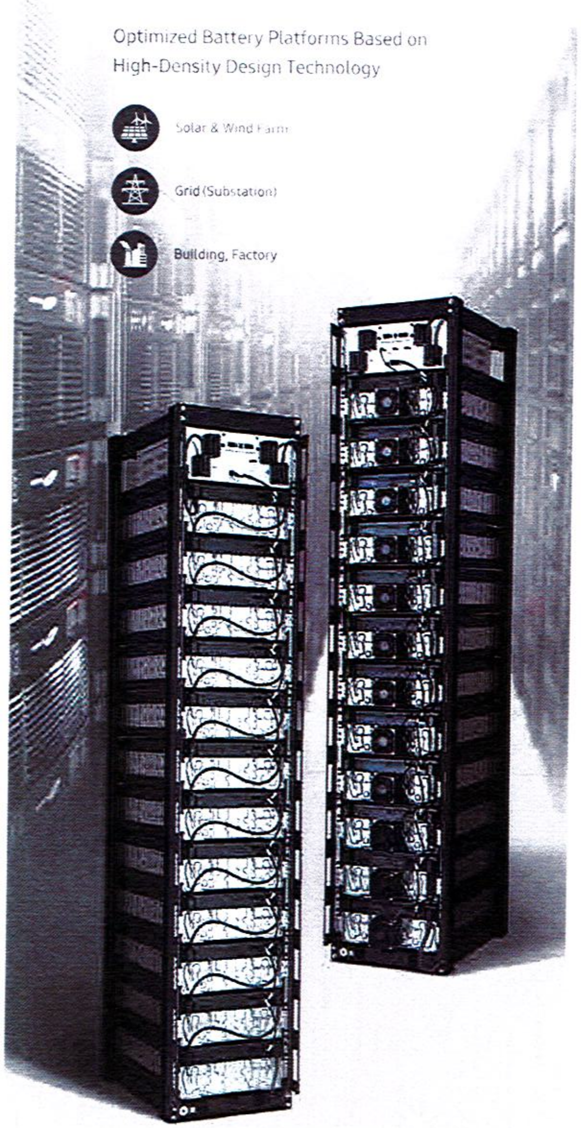
Accurate Lifetime Simulation

Samsung SDI offers optimal battery solution with its superior lifetime prediction technology. We design and propose a battery system with analyzing the various parameter such as purpose, operation period and installation environment.

Battery Platform for
Utility & Commercial ESS

Optimized Battery Platforms Based on High-Density Design Technology

- Solar & Wind Farm
- Grid (Substation)
- Building, Factory

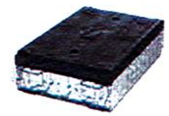


Standard Platform

Energy Platform New

Over 2 hours

- Energy density has increased more than 16% with upgrades to Samsung SDI's new advanced module
- Higher density enables better footprint and installation cost savings

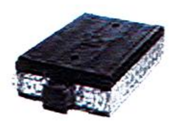


Item		Module	Rack		
Model		ES M088	ES R168	ES R203	ES R221
Cell Capacity	Ah	300	300	300	300
Energy	kWh	8.8	168	203	221
Operating Voltage	V	38.4–49.8	730–946	883–1,145	960–1,245
Dimension (W x D x H)	mm	570 x 657 x 160	876 x 711 x 1,795	876 x 711 x 2,325	876 x 711 x 2,289
Weight	kg	61	1,268	[illegible]	[illegible]

Medium Platform

1 hour up to 45 minutes

- Unique Platform in the ESS Industry with Mid-range Capabilities
- Optimized Solution for around One hour of Grid Service
- The Highest Lifetime Performance in a Continuous Charge/Discharge for 1 hour



Item		Module	Rack		
Model		MS M081	MS R073	MS R089	MS R097
Cell Capacity	Ah	100	100	100	100
Energy	kWh	8.1	73	89	97
Operating Voltage	V	70.4–91.3	634–822	774–1,004	845–1,096
Dimension (W x D x H)	mm	570 x 650 x 160	438 x 711 x 1,791	438 x 711 x 2,325	438 x 711 x 2,289
Weight	kg	56	564	685	742

Power Platform

30 minutes up to 20 minutes

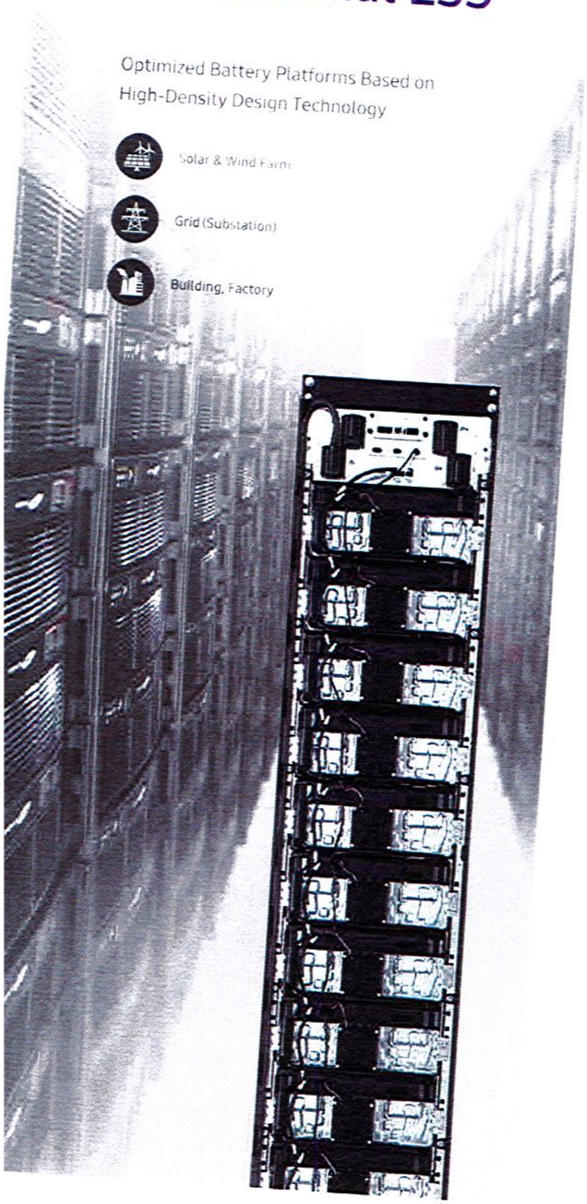
- High Power Platform Optimized for Less than 30 minutes of Use
- Optimized Solution for Power Applications such as F/R, Railway, Ship, etc.

Item		Module	Rack		
Model		PS M065	PS R057	PS R070	PS R076
Cell Capacity	Ah	78	78	78	78
Energy	kWh	6.5	57	70	76
Operating Voltage	V	68.2–90.2	614–812	750–992	818–1,082
Dimension (W x D x H)	mm	570 x 650 x 160	438 x 711 x 1,791	438 x 711 x 2,325	438 x 711 x 2,289
Weight	kg	54	560	575	738

Battery Platform for
Utility & Commercial ESS

Optimized Battery Platforms Based on High-Density Design Technology

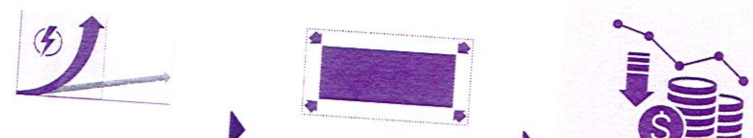
- Solar & Wind Farm
- Grid (Substation)
- Building, Factory



Special Platform

1,500 High Voltage Platform New

- High Efficiency Battery Solution for 1,500V PCS



Minimize Power Loss
by Enabling High PowerOutput

Minimize Total Footprint
by Reducing Footprint of PCS and Battery System

Maximize Economics & Efficiency

Utility & Commercial ESS

Product Lineup

Item		Rack		
Model		ES R256	MS R130	PS R101
Platform		Energy	Medium	Power
Backup Time		2 hours	1 hour	30 minutes
Cell Capacity	Ah	100	100	78
Energy	kWh	256	130	101
Operating Voltage	V	1,114~1,444	1,126~1,460	1,092~1,443
Dimension (W x D x H)	mm	876 x 711 x 2,750	438 x 711 x 3,082	438 x 711 x 3,082
Weight	kg	1,929	1,001	965

Global Track Record

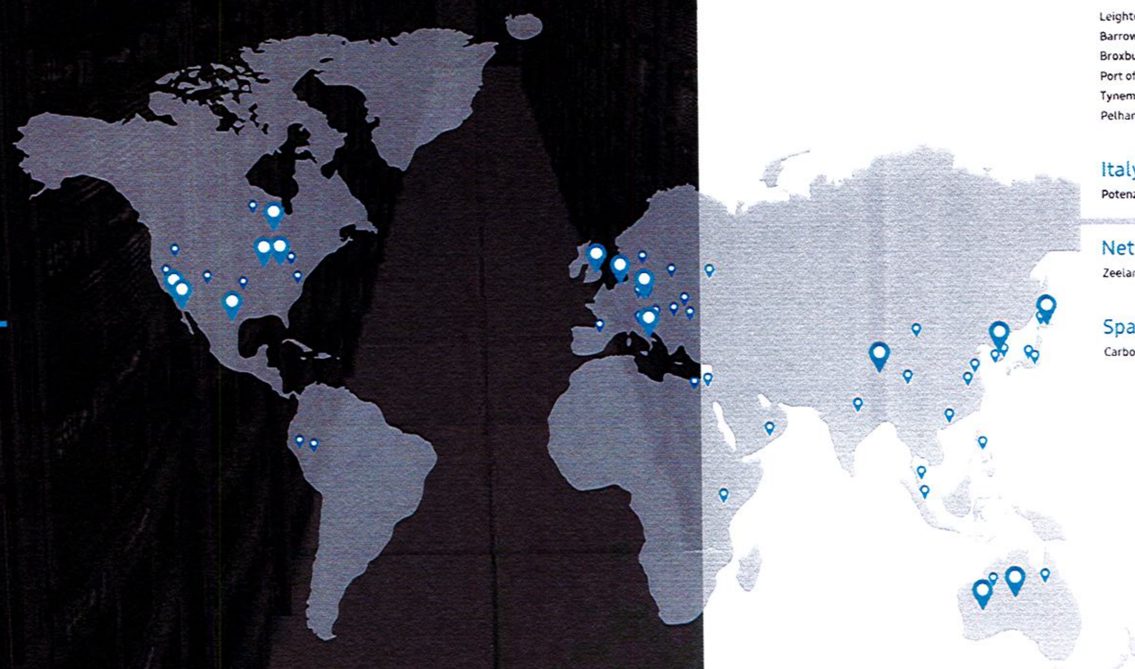
Since 2010, Samsung SDI's ESS products have been successfully operating in over 30 countries.

Today, Samsung SDI continues to make history by leading the growing global ESS market, based on best in class battery technology and strong partnerships.

SINCE
'10

COUNTRIES
30+

TOTAL GWh
10+



Americas

USA

California 150MWh Deployed 2017~

Austin, TX 36MW / 14MWh
El Cajon/Escondido, CA 37.5MW / 150MWh
Pomona, CA 20MW / 80MWh
Indianapolis, IN 20MW / 20MWh
El Centro, CA 30MW / 20MWh
Tucson, AZ 10MW / 5MWh
Punta Gorda, FL 10MW / 40MWh

Canada

Sault Sainte Marie, Ontario 8MW / 8MWh

Europe

Germany

Schwerin 15MWh Deployed 2014/17~

Schwerin 15MW / 15MWh
Chemnitz 10MW / 10MWh
Hassfurth 10MW / 10MWh

UK

Leighton Buzzard 10MWh Deployed 2014~

Leighton Buzzard 6MW / 10MWh
Barrow in Furness 49MW / 25MWh
Broxburn 20MW / 22MWh
Port of Tyne 36MW / 28MWh
Tynemouth 25MW / 17MWh
Pelham 50MW / 50MWh

Italy

Potenza 2MW / 2MWh

Netherlands

Zeeland 10MW / 10MWh

Spain

Carboneras 20MW / 12MWh

Asia & Oceania

Korea

KEPCO F/R 38MWh Deployed 2015~

KEPCO(5 Sites) 128MW / 38MWh
KOEN(3 Sites) 22MW / 63MWh
PyeongChang 6MW / 18MWh
Ulsan 24MW / 51MWh

China

Tibet 28MWh(2 Sites) Deployed 2016~

Tibet Shuanghu 4MW / 14MWh
Tibet Gaize 4MW / 14MWh

Japan

Hokkaido 25+MWh(3 Sites) Deployed 2017~

Hokkaido Shinhidaka 17MW / 9MWh
Hokkaido Chitose 17MW / 14MWh

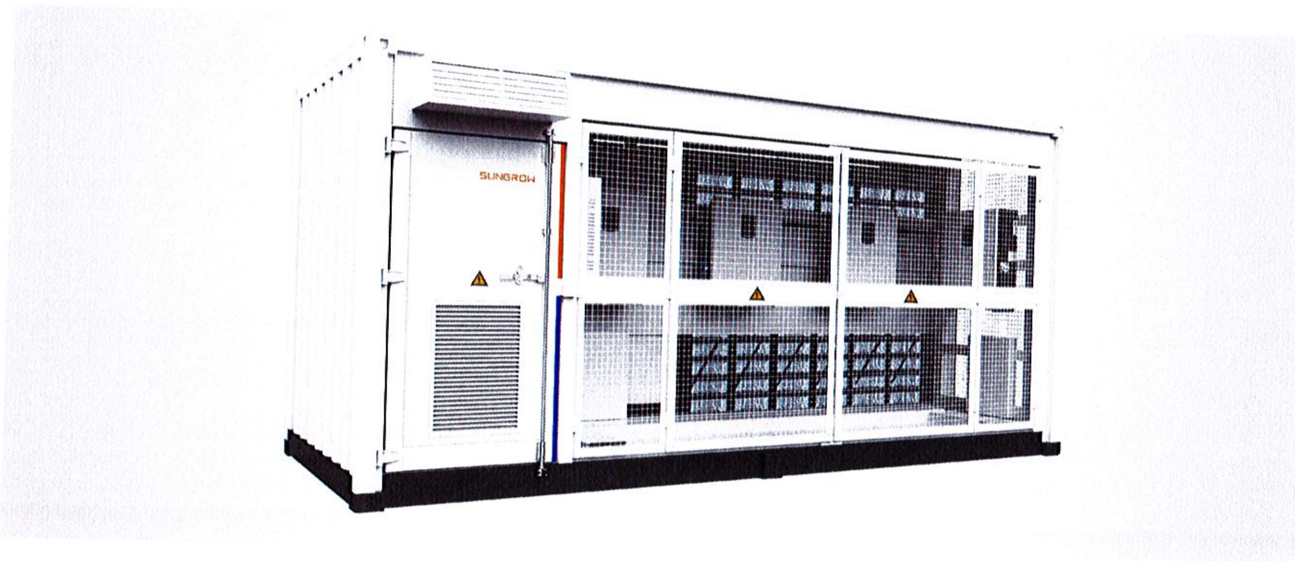
Australia

Alice Spring 4MW / 2MWh
Western Australia 4MW / 2MWh
Adelaide 30MW/15MWh

SUNGROW | SAMSUNG SAMSUNG SDI

ST548KWH-D250HV +4xSG125HV

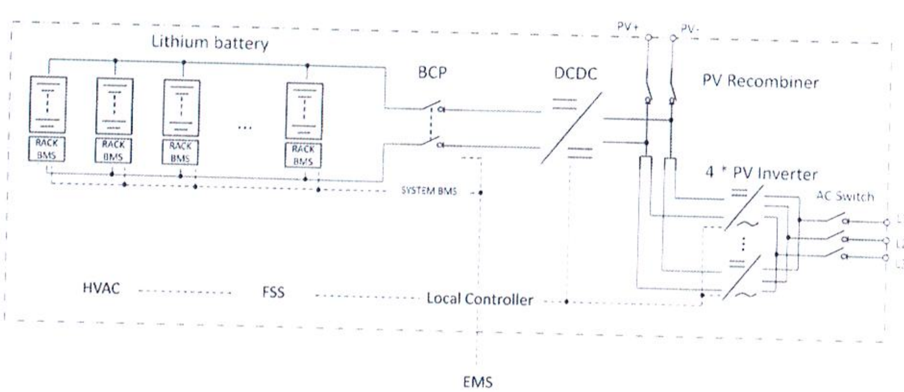
Storage System



SYSTEM FEATURES

- ESS system integrated with PV inverter
- 1500V DC coupled PV+ESS system
- Compact mechanical design,minimized footprint
- High efficient system with safe and long lifecycle lithiun-ion battery
- Integrated local controller, HVAC and FSS to enable unified communication and ensure system safety

CIRCUIT DIAGRAM



System Type	ST548KWH-D250HV+4xSG125HV
PV Data	
Max PV input voltage	1,500 V
MPPT voltage range at nominal power	860 ~ 1,250 V
Number of DC inputs	5
Max. PV input current	1,250 A
DCDC Data	
Working voltage range	500 ~ 1,500 V
Nominal power	250 kW
Max. current	344 A
Battery Data	
Cell type	Samsung SDI Mega E2, 3.68 V / 94 Ah
Configuration of system	264S6P
Battery capacity (BOL)	548 kWh
Battery voltage range	844 ~1,095 V
AC Data	
AC output power	500kVA @ 50 ℃
Max. AC output current	480 A
Nominal AC voltage	3 / PE, 600 V
AC voltage range	480 ~ 690 V
Nominal grid frequency / Grid frequency range	60 Hz / 55 ~ 65 Hz
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading ~ 0.8 lagging
Feed-in phases / connection phases	3/3
General Data	
Dimensions (W * H * D)	6,058 * 2,896 * 2,438 mm / 238.5'' * 114.0'' * 96.0''
Weight (with / without battery)	12.5 T / 8.6 T, 27,558 lbs / 18,960 lbs
Degree of protection	IP 54 / NEMA 3R
Operating temperature range	-30 to 50 ℃ / -22 to 122 ℉
Relative humidity	0 ~ 95 % (non-condensing)
Max. working altitude	2,000 m / 6,562 ft
Cooling concept of battery chamber	Heating, ventilation and Air Conditioning
Fire suppression system of battery unit	FM-200 extinguishment system
Communication interfaces	RS485, Ethernet
Communication protocols	Modbus RTU, Modbus TCP
Compliance	UL9540

APPLICATION

ANSUL®

Power Generation

CHALLENGE:
Protecting sub-stations, electrical switch rooms, control rooms, data communications and other critical areas

SOLUTION:
ANSUL® FM-200™ Clean Agent Fire Suppression System

APPLICATION:
Protecting critical operational infrastructure in cramped conditions

Power stations and power generation facilities incorporate a wide range of critical and ancillary services and buildings to ensure continued operations and plant uptime. Away from the primary power circuit, boiler and turbine system; vital facilities such as sub-stations, cable voids, control rooms, data communications and backup systems must be effectively protected against fire risk. Selecting the right solution to protect this critical plant infrastructure is key.

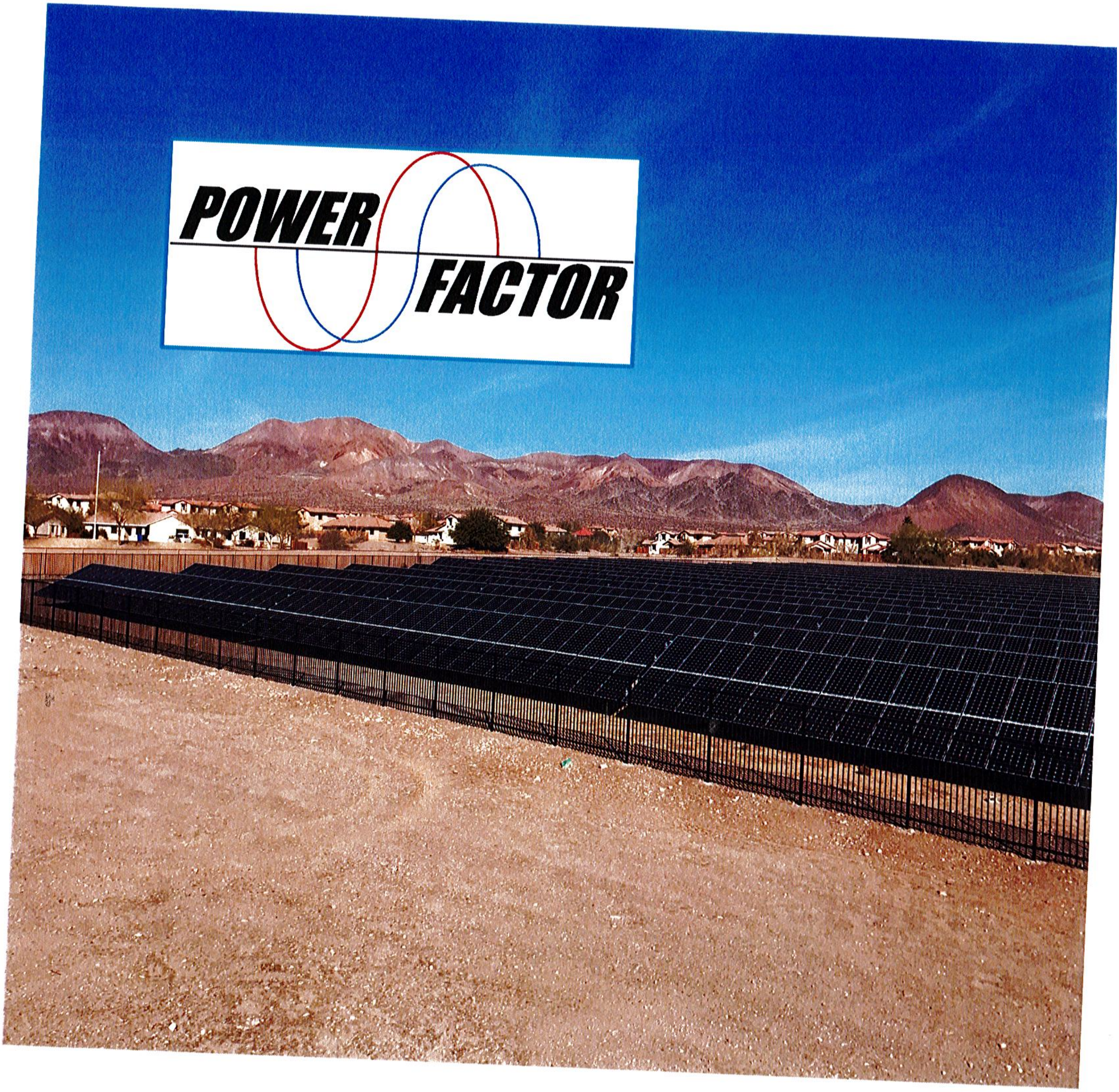
The ANSUL FM-200 Clean Agent Fire Suppression System has zero ozone depletion potential (ODP). The system uses FM-200 (HFC-227ea) fire extinguishant which vaporizes upon discharge and absorbs heat to rapidly suppress fire. This results in less damage to critical equipment, facilitating a much shorter recovery time and reducing downtime. Safe for use in occupied areas at the design concentration, the system helps protect critical infrastructure and delivers effective asset protection for power generation facilities.

The ANSUL FM-200 system is most effective when used with the automatic AUTOPULSE Detection and Control System to introduce the clean agent rapidly. This detection system is used to actuate a single, fixed fire suppression or alarm system based on inputs received from fire detection devices. The detection circuits can be configured using cross, counting, independent or priority-zone concepts.

Both automatic and manual actuators are available for release of the agent into the hazard area through fixed piping and nozzles. Seven nozzle sizes are available to provide the correct flow of agent in either 180 or 360 horizontal discharge patterns. For large hazards, cylinders can be connected to a common manifold.

The ANSUL FM-200 system carries UL, FM and ULC, as well as marine approvals. The system can be designed to meet the requirements of EN 15004, ISO 14520 and NFPA 2001 with components approved to provide the highest quality fire suppression system.

One Stanton Street / Marinette, WI 54143-2542, USA / +1-715-735-7411 / www.ansul.com



O&M PROPOSAL

George Lang IV
Andrew@powerfactorco.com

O&M Proposal

Part 1: Bidder Contact Information

Bidder Contact Information
Corporate Name: Power Factor, LLC
Corporate Address: 8240 Beachwood road, Dundalk MD 21222
Parent's Corporate Name: Power Factor LLC
Parent's Corporate Address: 8240 Beachwood road, Dundalk MD 21222
Legally Authorized Representative
Name: George Lang
Title: Managing Director
Phone: (443) 827 7543
Fax:
E-mail: george@powerfactorco.com
Signature:
Primary Contact:
Name: Andrew Streit
Title: Director of Business Development
Phone: (803) 665-6688
Fax:
E-mail: andrew@powerfactorco.com
Signature:

Part 2: Executive Summary

Power Factor is honored to submit our qualifications for solar photovoltaic operations and maintenance services to Amesbury Line Solar LLC. Our company is ideally situated to deliver professionalism, excellence, efficiency and durability to Amesbury Line Solar in its efforts to successfully deploy solar projects on its properties. Due to a decade of involvement in developing customized renewable energy projects for public and private clients, Power Factor has an intimate understanding of the energy market in the southeastern United States. Our previous work with public entities has demonstrated that an elevated level of execution and delivery are the minimum standard for every government contract. We are prepared to meet and exceed those standards.

- Power Factor brings with it an experienced team of solar professionals that have successfully completed a large portfolio of projects ranging from rooftop solar arrays to solar parking canopies to utility scale solar farms.
- Power Factor has successfully deployed solar systems for a number of public entities, including various military and municipal installations.
- Power Factor has worked hand-in-hand with utilities, electric cooperatives, regulators, and private and public-sector entities to find economic, clean energy solutions that satisfy the aesthetic and sustainability goals of the client.
- Power Factor has amassed the professional capacity to manage projects on time and on budget even in the midst of challenging circumstances.
- Power Factor's reputation and history of successful solar project management should provide Amesbury Line Solar with the confidence it needs when selecting an experienced, knowledgeable operations and maintenance firm for this project.

Sustainability is not a catch phrase. It is the foundation of successful organizations. Power Factor recognizes that inventing and deploying the nation's utility grid was the single most important investment of the 20th century. Improving efficiency and eliminating waste will be primary drivers for the public and private sectors during the years to come. Given Power Factor's expertise and passion for the advancement of solar as a mainstream component of our country's energy portfolio, we are well prepared to lead in the realization and execution of these maintenance agreements. We are confident that our services will bring with them maximum value to Amesbury Line Solar and will result in a durable sustainability commitment. Power Factor is genuinely excited about our potential role in this process. We are proposing to provide all the preventative and corrective maintenance options requested, as well as providing training of any interested on-site personnel.

O&M Proposal

Preventive Maintenance Requirements and Costs

List of services:

Standard

Preventative Maintenance Work Scope	
Array Balance System	**Yes/No**
Array visual inspection-wire management, connector tightness, and insulation inspection	Yes
Array ground/racking debris removal and vegetation inspection	Yes
Verify fence condition and grounding	Yes
Inspect system and site drainage	Yes
Module Visual Inspection	**Yes/No**
Inspect 100% of glass side for cleanliness and obvious defects	Yes
Inspect 100% of back-sheet a J-Boxes	Yes
Inspect 100% of module clamps for looseness	Yes
String Inverters (Central Inverters vary by Size/Band)	**Yes/No**
Inspect for corrosion, labelling and basic condition of housing	Yes
Verify functionality of display and operation of PV system	Yes
Inspect base of inverter and conduit entry points	Yes
Clean inverter interior and inspect for moisture intrusion	Yes
Check string fuse functionality	Yes
Check ground straps and ensure all grounds are intact and tight to the enclosure	Yes
Clean heat sink and filters (replace filters if necessary)	Yes
Torque AC and DC conductors connections to manufacturers specs	Yes
IR scan all string terminations	Yes
AC/DC Disconnections & Panel Boards	**Yes/No**
Cycle all movable parts in AC/DC disconnect & Panel Boards	Yes
Torque all conductor connections to manufacturers specs	Yes
IR scan all string terminations	Yes
DAS & MET Stations	**Yes/No**
Inspect cabinet for labelling, corrosion, moisture intrusion and basic conditions of housing	Yes
Ensure all conductors and wires are routed in a neat and clean manner	Yes
Torque data terminations to manufacturers specs	Yes
Clean reference cell and/or pyranometer (Replace desiccant)	Yes
Verify functionality of all DAS Components	Yes
Other Services (Please list below)	**Yes/No**

Corrective Maintenance Requirements and Costs

Corrective Maintenance (CM) Services are generally triggered by a monitoring alert reporting an issue at the site. Certain alerts can be corrected remotely, while more severe alerts can require an emergency response due to safety concerns, or (far more typically) permit the on-site service call to be scheduled.

Please indicate which services your company provides and the respective costs associated with typical corrective maintenance service visit in the O&M bid below. The preferred cost structure can be in terms of Hourly, Half Day, or Full Day Rate.

Standard

Corrective Maintenance Work Scope	
Common Corrective Maintenance Task	**Yes/No**
Inverter troubleshooting and warranty management	Yes
String and Connector repairs	Yes
Panel Replacements	Yes
Panel manufacturer defect identification and tracking	Yes
Monitoring troubleshooting and repair	Yes
Fuse replacements	Yes
Breaker tightening and replacement	Yes
Transformer Oil Sampling	Yes
Ground fault identification	Yes
System wide IV Curve testing	Yes
Aerial or customized IR thermal imaging	Yes
Power Quality Analysis	Yes
Additional Services May Include	**Yes/No**
Auditing/correcting sites installed by others	Yes
Commissioning of sites installed by others	Yes
Medium Voltage and Fiber Optic Services	Yes
Other Services (Please list below)	**Yes/No**

Cost Structure for Above Indicated Services (Fill in all that apply)	
Hourly Rate	$75/hr
Half Day Rate	$250
Full Day Rate	$500

Typical Rate Sheet for Additional Services

O&M Proposal

Service Levels and Rates		
Service	**Description**	**Rate**
Medium Voltage Electrician	Electrical fault repair, upgrades and modifications, field engineering, transformer testing, underground fault location, site management	$100/hr
Master Electrician	Electrical fault repair, upgrades and modifications, field engineering, transformer testing, underground fault location, site management	$75/hr
Level 3 Datacom Electrician	Advanced Datacom troubleshooting, fiber repair, level 1 and 2 capable	$50/hr
Level 2 Technician	Inverter and Datacom second level troubleshooting, panel testing, fuse and cable replacement. Captures IV Curves, IR Images and Power Quality measurements. OEM repairs	$36/hr
Level 1 Technician	Inverter and Datacom resets. Primary troubleshooting, records site data and fault codes. Replaces solar panels, was panels, and completes basic electrical and mechanical repairs	$25/hr
Professional Services	Performance engineering, integration services, system designs, commissioning review, project management and services oversight	$47/hr
Travel Charges	For teams of 2: Labor + Mileage	
Per Diem	For teams of 2: Overnight Accommodations	$250
Overtime	Workdays exceeding 8 hours	
Emergency Response	Deploy within 4 hours of notification	
Specialized Site Services		
Service	**Description**	**Rate**
Transformer Service	Sample of transformer fluid for DGA, refill nitrogen, includes all labor, laboratory and material costs	
Technical Services	Underground Fault Location (UFL), Infra-Red Imaging Diagnostics (IR Imaging), Module and String level I-V Characterization (IV Curves), DC/AC Power Quality Analysis (PQA)	
Other Services (Please list below)		
Service	**Description**	**Rate**

Onsite training for Amesbury Line Solar

Power Factor is happy to offer Amesbury Line Solar training services.

Training Services and Rates		
Training	**Description**	**Rate**
1-Day Training	Training to be held for Points of Contacts at a location provided by AMESBURY LINE SOLAR	$25/hr
Customize in-class training	Half Day training(s) on specific topics of need for AMESBURY LINE SOLAR	$50/hr
Field Shadowing	On-site, hands-on training	$25/hr
Not Applicable	Our company does not provide specific training	

Credibility

References:

- Maryland Management
  Christopher Dimario
  Rental Property Owner/Manager
  Cdimario@Marylandmgmt.com

- URI (Unlimited Restoration Inc)
  Rodney O'Neal
  Co-Owner
  ROneal@urinow.com

- Onyx renewable Partners
  Greg Cousoulas
  Sr VP of Construction
  On file

- Uhaul
  Jim Dickerson
  Owner Representative
  jim_dickerson@uhaul.com

Planning Board Decision not required for Application.

Approved Site Plan not required for Application.

No Zoning Waivers required.

Applicant is seeking Two Special permits Only

O&M PROPOSAL

George Lang IV
Andrew@powerfactorco.com

O&M Proposal

Part 1: Bidder Contact Information

Bidder Contact Information
Corporate Name: Power Factor, LLC
Corporate Address: 8240 Beachwood road, Dundalk MD 21222
Parent's Corporate Name: Power Factor LLC
Parent's Corporate Address: 8240 Beachwood road, Dundalk MD 21222
Legally Authorized Representative
Name: George Lang
Title: Managing Director
Phone: (443) 827 7543
Fax:
E-mail: george@powerfactorco.com
Signature:
Primary Contact:
Name: Andrew Streit
Title: Director of Business Development
Phone: (803) 665-6688
Fax:
E-mail: andrew@powerfactorco.com
Signature:

Part 2: Executive Summary

Power Factor is honored to submit our qualifications for solar photovoltaic operations and maintenance services to Amesbury Line Solar LLC. Our company is ideally situated to deliver professionalism, excellence, efficiency and durability to Amesbury Line Solar in its efforts to successfully deploy solar projects on its properties. Due to a decade of involvement in developing customized renewable energy projects for public and private clients, Power Factor has an intimate understanding of the energy market in the southeastern United States. Our previous work with public entities has demonstrated that an elevated level of execution and delivery are the minimum standard for every government contract. We are prepared to meet and exceed those standards.

- Power Factor brings with it an experienced team of solar professionals that have successfully completed a large portfolio of projects ranging from rooftop solar arrays to solar parking canopies to utility scale solar farms.
- Power Factor has successfully deployed solar systems for a number of public entities, including various military and municipal installations.
- Power Factor has worked hand-in-hand with utilities, electric cooperatives, regulators, and private and public-sector entities to find economic, clean energy solutions that satisfy the aesthetic and sustainability goals of the client.
- Power Factor has amassed the professional capacity to manage projects on time and on budget even in the midst of challenging circumstances.
- Power Factor's reputation and history of successful solar project management should provide Amesbury Line Solar with the confidence it needs when selecting an experienced, knowledgeable operations and maintenance firm for this project.

Sustainability is not a catch phrase. It is the foundation of successful organizations. Power Factor recognizes that inventing and deploying the nation's utility grid was the single most important investment of the 20th century. Improving efficiency and eliminating waste will be primary drivers for the public and private sectors during the years to come. Given Power Factor's expertise and passion for the advancement of solar as a mainstream component of our country's energy portfolio, we are well prepared to lead in the realization and execution of these maintenance agreements. We are confident that our services will bring with them maximum value to Amesbury Line Solar and will result in a durable sustainability commitment. Power Factor is genuinely excited about our potential role in this process. We are proposing to provide all the preventative and corrective maintenance options requested, as well as providing training of any interested on-site personnel.

O&M Proposal

Preventive Maintenance Requirements and Costs
List of services:

Standard

Preventative Maintenance Work Scope	
Array Balance System	**Yes/No**
Array visual inspection-wire management, connector tightness, and insulation inspection	Yes
Array ground/racking debris removal and vegetation inspection	Yes
Verify fence condition and grounding	Yes
Inspect system and site drainage	Yes
Module Visual Inspection	**Yes/No**
Inspect 100% of glass side for cleanliness and obvious defects	Yes
Inspect 100% of back-sheet a J-Boxes	Yes
Inspect 100% of module clamps for looseness	Yes
String Inverters (Central Inverters vary by Size/Band)	**Yes/No**
Inspect for corrosion, labelling and basic condition of housing	Yes
Verify functionality of display and operation of PV system	Yes
Inspect base of inverter and conduit entry points	Yes
Clean inverter interior and inspect for moisture intrusion	Yes
Check string fuse functionality	Yes
Check ground straps and ensure all grounds are intact and tight to the enclosure	Yes
Clean heat sink and filters (replace filters if necessary)	Yes
Torque AC and DC conductors connections to manufacturers specs	Yes
IR scan all string terminations	Yes
AC/DC Disconnections & Panel Boards	**Yes/No**
Cycle all movable parts in AC/DC disconnect & Panel Boards	Yes
Torque all conductor connections to manufacturers specs	Yes
IR scan all string terminations	Yes
DAS & MET Stations	**Yes/No**
Inspect cabinet for labelling, corrosion, moisture intrusion and basic conditions of housing	Yes
Ensure all conductors and wires are routed in a neat and clean manner	Yes
Torque data terminations to manufacturers specs	Yes
Clean reference cell and/or pyranometer (Replace desiccant)	Yes
Verify functionality of all DAS Components	Yes
Other Services (Please list below)	**Yes/No**

Corrective Maintenance Requirements and Costs

Corrective Maintenance (CM) Services are generally triggered by a monitoring alert reporting an issue at the site. Certain alerts can be corrected remotely, while more severe alerts can require an emergency response due to safety concerns, or (far more typically) permit the on-site service call to be scheduled.

Please indicate which services your company provides and the respective costs associated with typical corrective maintenance service visit in the O&M bid below. The preferred cost structure can be in terms of Hourly, Half Day, or Full Day Rate.

Standard

Corrective Maintenance Work Scope	
Common Corrective Maintenance Task	**Yes/No**
Inverter troubleshooting and warranty management	Yes
String and Connector repairs	Yes
Panel Replacements	Yes
Panel manufacturer defect identification and tracking	Yes
Monitoring troubleshooting and repair	Yes
Fuse replacements	Yes
Breaker tightening and replacement	Yes
Transformer Oil Sampling	Yes
Ground fault identification	Yes
System wide IV Curve testing	Yes
Aerial or customized IR thermal imaging	Yes
Power Quality Analysis	Yes
Additional Services May Include	**Yes/No**
Auditing/correcting sites installed by others	Yes
Commissioning of sites installed by others	Yes
Medium Voltage and Fiber Optic Services	Yes
Other Services (Please list below)	**Yes/No**

Cost Structure for Above Indicated Services (Fill in all that apply)	
Hourly Rate	$75/hr
Half Day Rate	$250
Full Day Rate	$500

Typical Rate Sheet for Additional Services

O&M Proposal

Service Levels and Rates		
Service	**Description**	**Rate**
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- Maryland Management
  Christopher Dimario
  Rental Property Owner/Manager
  Cdimario@Marylandmgmt.com

- URI (Unlimited Restoration Inc)
  Rodney O'Neal
  Co-Owner
  ROneal@urinow.com

- Onyx renewable Partners
  Greg Cousoulas
  Sr VP of Construction
  On file

- Uhaul
  Jim Dickerson
  Owner Representative
  jim_dickerson@uhaul.com

Temporary construction access easement agreement

This temporary construction access easement agreement is entered into this 26 day of March 2021 by Albert Duchemin and Jual Realty Trust whose legal address is 235 Amesbury Line Rd Haverhill,Mass.

Collectively the Grantor, And Michael Harrington of Harrington Excavating of 358 Grafton st. Shrewsbury,Mass .as grantee

In consideration of the easement grantee agree's to repair and grade Mr Duchemin driveway and remove the tree,s he requested.

[redacted] also agreed because of the temporary construction easement when site is running albert Duchemin would get a [redacted]%credit on his power bill for the next [redacted] years.

The Temporary Construction easement is granted to grantee' and is for vehicle's and pedestrian and ingress and egress to do all things reasonably necessary to construct and install the project including transporting,stockpiling,storage materials,equipment and vehicles.

The grantee,at its sole cost and expence,shall restore temporary easement to its original condition.

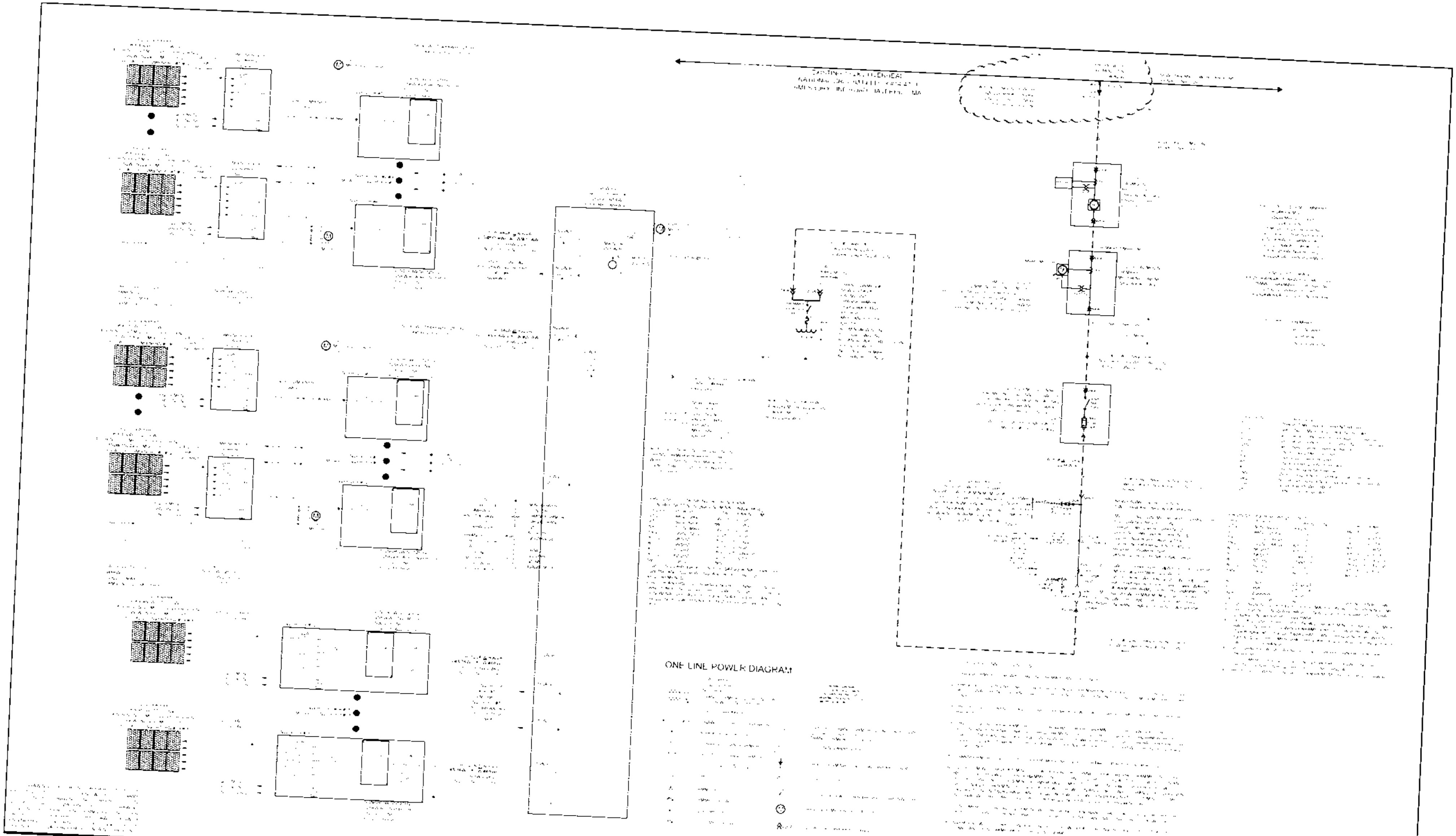
The easement also allows the town inspectors and consultants access till the completion of project.

Albert Duchemin and Jual Realty trust

Albert H Duchemin

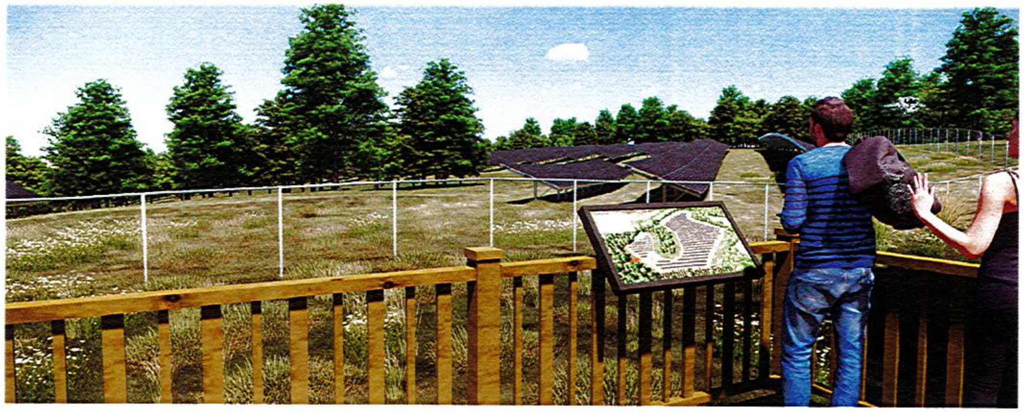
Michael Harrington Harrington Excavating

Michael Harrington

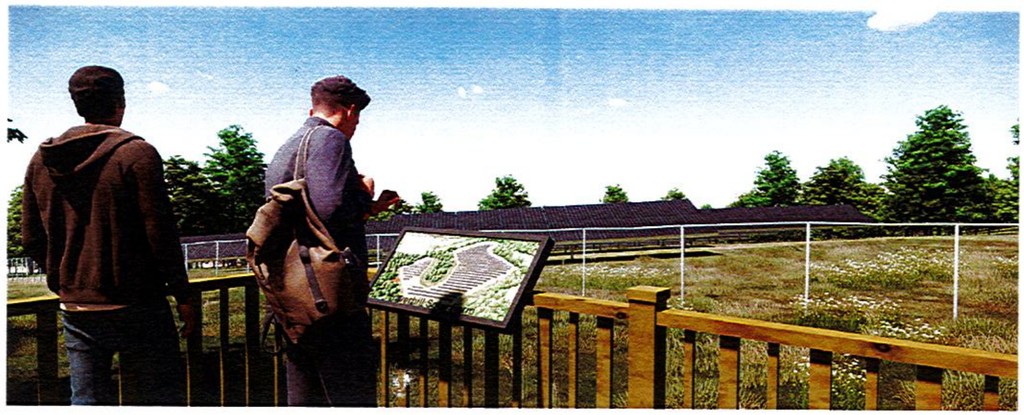


2,000KW AC PV SYSTEM WITH
750KW DC COUPLED ENERGY STORAGE
LIMITED TO 2,000KW AC TOTAL OUTPUT

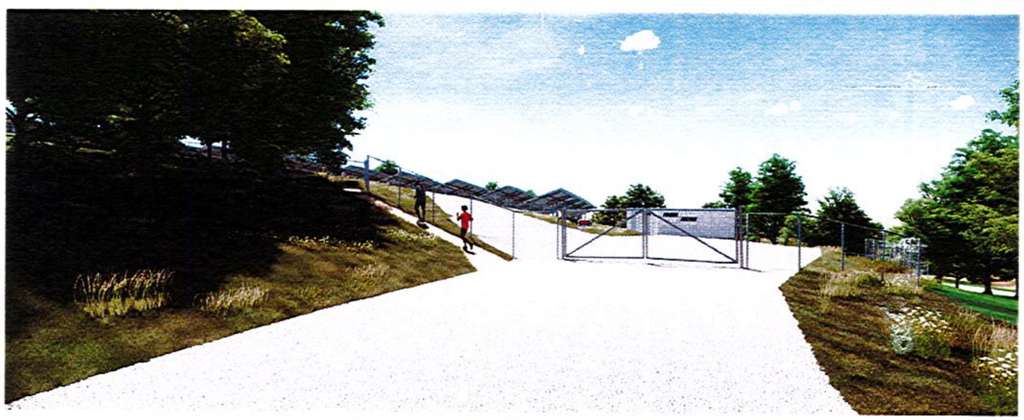
POWER ENGINEERS, LLC	POWER FACTOR 139 AMESBURY LINE ROAD 1,560KW AC ONE-LINE DIAGRAM		E-1
06-22-2021	HAVERHILL	MASSACHUSETTS	SIZE D REV 9



ILLUSTRATIVE VIEW FROM WEST EDUCATION PLATFORM
PROVIDED BY ANDREW STREIT OF POWER FACTOR



ILLUSTRATIVE VIEW FROM EAST EDUCATION PLATFORM
PROVIDED BY ANDREW STREIT OF POWER FACTOR



ILLUSTRATIVE VIEW ENTERING MAIN GATE
PROVIDED BY ANDREW STREIT OF POWER FACTOR

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION

■ PERMIT ☐ CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.

PER 250 CMR 5.05(3), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION, LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES, DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION

GPR Engineering Solutions for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.
39 MAIN STREET, SUITE 301, AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978.772.1590 FAX: 978.772.1591
www.gpr-inc.com

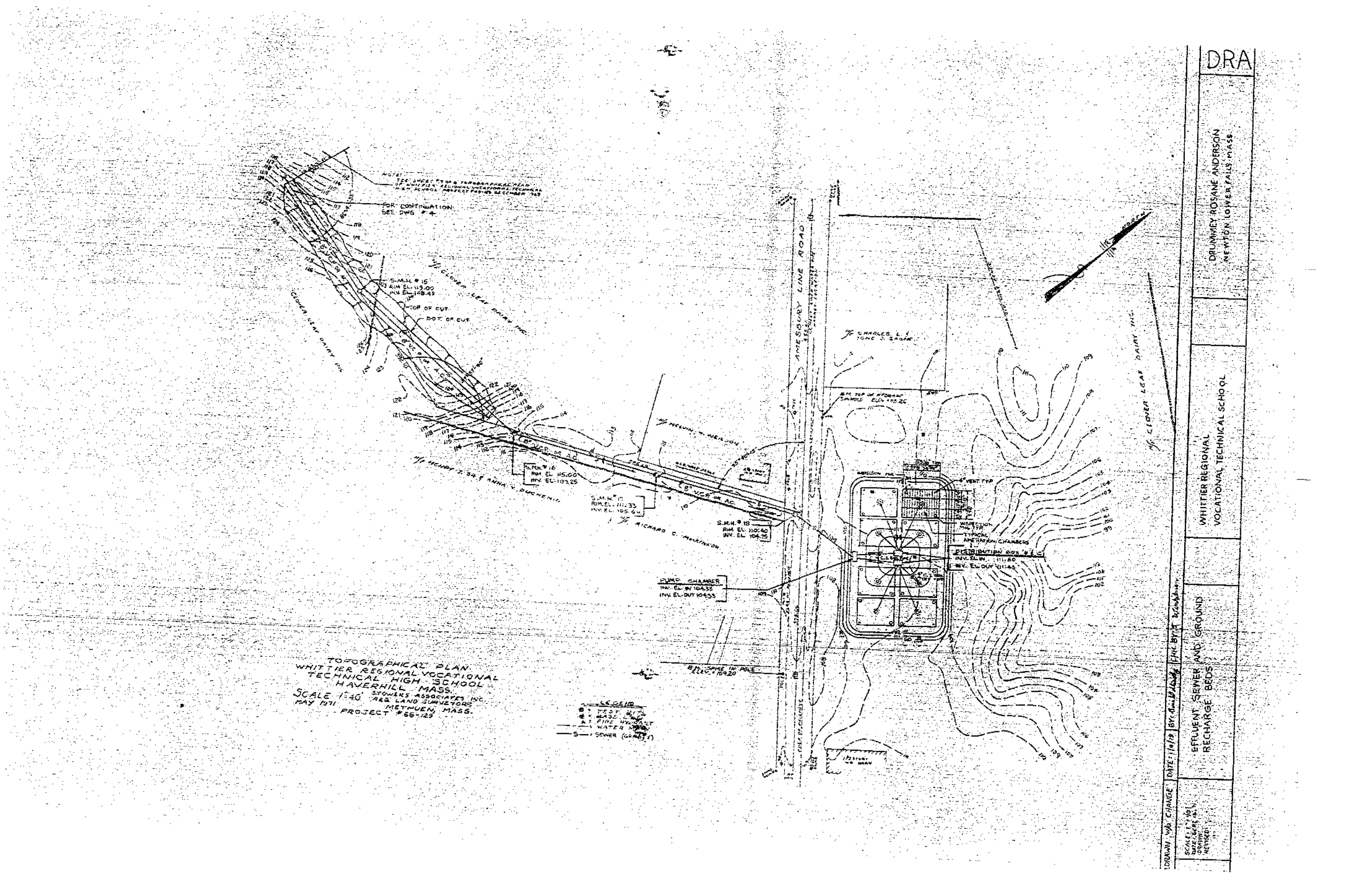
SOLAR PHOTOVOLTAIC PROJECT

SOLAR FARM ILLUSTRATIVES

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD.
SUMMERVILLE, SC 29483

DES. BY: JJD CHK. BY: AER	DATE: APRIL 2021	JOB 181084	5 OF 1


TOPOGRAPHICAL PLAN
WHITTIER REGIONAL VOCATIONAL
TECHNICAL HIGH SCHOOL
HAVERHILL MASS.
SCALE 1"=40'
MAY 1971
STOWERS ASSOCIATES INC.
REG. LAND SURVEYORS
METHUEN, MASS.
PROJECT #66-123
AMESBURY LINE ROAD
FOR CONTINUATION SEE DWG #4
TOP OF CUT
BOT. OF CUT
PUMP CHAMBER
DISTRIBUTION BOX
TYPICAL AERATION CHAMBERS
LEGEND
DRUMMEY ROSANE ANDERSON
NEWTON LOWER FALLS MASS.
WHITTIER REGIONAL
VOCATIONAL TECHNICAL SCHOOL
EFFLUENT SEWER AND GROUND
RECHARGE BEDS
DRA

36/176

PLAN BOOK 176 PLAN 36
ESSEX REGISTRY OF DEEDS, SO. DIST.
SALEM, MASS.
Received January 21 1983
with Deed: Cecil R. Hutchinson et al
to Theodore Xenakis
Bk. 2 7016 P 422.
Attest: John L. O'Brien Jr.
Register of Deeds

FOR REGISTRY USE

THIS PLAN DOES NOT REQUIRE APPROVAL
UNDER THE SUBDIVISION CONTROL LAW
HAVERHILL PLANNING BOARD
DATE

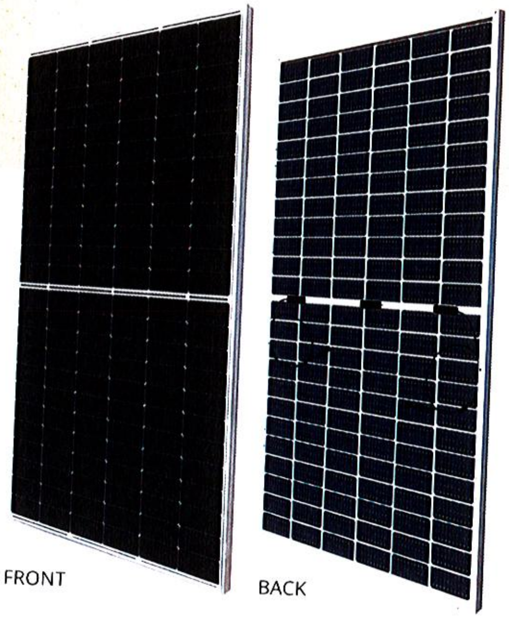
HAVERHILL SOLAR FARM
139 AMESBURY LINE ROAD

SOLAR SYSTEM COMPONENTS
(AMENDED 8/16/2021)
-CANADIAN SOLAR MODULES
-DCE SOLAR RACKING
-SAMSUNG LITHIUM ION BATTERIES
-SUNGROW BATTERY HOUSING
-ANSUL FM200 CLEAN FIRE SUPPRESSION
-ENVIROTEMP DIELECTRIC COOLANT
-FIRE LANE CART PATH TREATMENT

NEW

Andrew to Update

CanadianSolar



BiHiKu6 Mono

BIFACIAL MONO PERC

520 W ~ 540 W

UP TO 30% MORE POWER FROM THE BACK SIDE

CS6W-520 | 525 | 530 | 535 | 540MB-AG

Dimensions: 2266 × 1135 × 35 mm (89.2 × 44.7 × 1.38 in)
Weight: 32.4 kg (71.4 lbs)
Max. System Voltage: 1500 V (IEC/UL) or 1000 V (IEC/UL)

MORE POWER

540 W — Module power up to 540 W
Module efficiency up to 21.0 %

Up to 12.3 % lower LCOE
Up to 5.2 % lower system cost

Comprehensive LID / LeTID mitigation technology, up to 50% lower degradation

Compatible with mainstream trackers, cost effective product for utility power plant

Better shading tolerance

MORE RELIABLE

Minimizes micro-crack impacts

Heavy snow load up to 5400 Pa, wind load up to 2400 Pa*

* For detailed information, please refer to the Installation Manual.

12 Years — Enhanced Product Warranty on Materials and Workmanship*

30 Years — Linear Power Performance Warranty*

1st year power degradation no more than 2%
Subsequent annual power degradation no more than 0.45%

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

* As there are different certification requirements in different markets, please contact your local Canadian Solar sales representative for the specific certificates applicable to the products in the region in which the products are to be used.

CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 43 GW deployed around the world since 2001.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

DCE SOLAR

Elevating the Future for Solar | Made in America

Contour™ DB-II

ASSEMBLY MANUAL

ISSUED: JULY 10TH, 2019 **REV-G**

Inspection Operation and Maintenance Procedure

Inspections During the System Warranty Period

Snow Removal

- Substantial snow accumulation that completely fills the gap between front of the panels and ground must be removed immediately to prevent excessive snow drift and ice dam formation. DCE Solar should be notified immediately of any structural issues and the issues should be documented with photos.

The following inspections should be performed at a minimum of every year of the warranty period.

Check Connections

- Visually inspect all bolted connections and verify that connections have not visually loosened (torque marks should be inline). Also look for any instance of slippage or part movement.
- Check the torque on 10% of the bolted connections to 80% of the torque value given in the installation manual. If 10% of the of the inspected hardware does not meet the 80% torque value, perform a site-wide inspection and retorque all similar connections.
- If any of the connections require re-torqueing, reinspect in 6 and notify DCE Solar. DCE solar should be notified on any instances where such corrective action is required.

Inspect Foundations

- Check for ground erosion and settlement around the foundation of the system and correct any site issues where excessive erosion, standing water, or other factors that could inhibit foundation performance.
- Ground screw system; check the height of the inside tube connected to the N/S beam to ensure no vertical moved has occurred.

Corrosion

Perform a visual inspection for evidence of corrosion on all structural components. Excessive corrosion is defined as:

- Any instance where red rust covers more than 5% of the total surface area
- Any localized or pitting corrosion where the structural performance of a component may be impeded.

Note: *It is common to observe white rust on galvanized components, this does not present any structural concern and requires no corrective action. It is common on pre-galvanized materials to observe red rust on cut edges or holes. This is typical and does not present any structural concern and requires no corrective action.*

Any component where the structural integrity has been compromised must be replaced immediately. Where the integrity of structural components has not been impacted, the galvanized coating should be repaired in accordance with the ASTM A780 Standard.

Contact

If any corrective action is required on a site, or if there are any questions or causes for concern from the site inspection, contact DCE Solar at 704 659-7477 or info@dcesolar.com.

SAMSUNG SDI

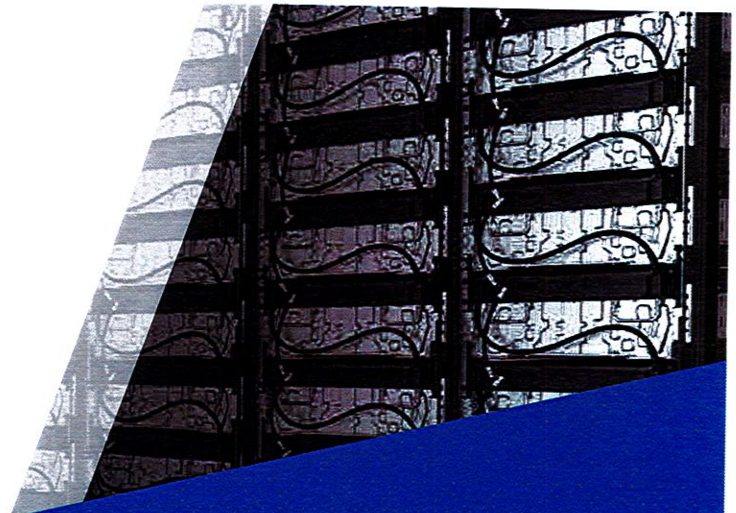
Energy Storage System
Battery Business

Global Network

KOREA (HQ)	150-20 Gongse-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17084, Korea TEL +82-31-210-8209 **E-mail** energy.storage@samsung.com
GERMANY	Reichenbachstrasse 2, 85737 Ismaning, Germany TEL +49-89-9292-7799(19) **E-mail** sintaek.yim@samsung.com
USA	3655 North 1st Street, San Jose, CA 95134, USA TEL +1-408-544-4491 **E-mail** hk1.kim@samsung.com
CHINA	No.788, Mingchuan Rd. Boyan Science & Technology Park.Hefei State Hi-tech Zone.P.R.China. TEL +86-551-6532-7500 **E-mail** hgleo.ryu@samsung.com
JAPAN	(108-0075) Shinagawa Grand Central Tower 9F, 2-16-4, Konan, Minato-ku, Tokyo, Japan TEL +81-3-6369-6414 **E-mail** m.goto@samsung.com
TAIWAN	7F-1, No.399, Ruiguang Rd., Neihu Dist., Taipei City 114, Taiwan TEL +886-2-8178-5974 **E-mail** allen01.chen@samsung.com

Feb. 2019

www.samsungsdi.com



ESS Batteries by Samsung SDI

Top Safety & Reliability Solutions

SAMSUNG SDI

SAMSUNG SDI

Creative Energy
& Materials Solution Leader

Samsung SDI is leading the change of a new era with lithium-ion batteries.

Through our constant innovation towards excellence,
we led with the technological superiority of our innovative IT devices
and expanded into electric cars which have now become reality.
In addition, we are contributing to the expansion of an eco-friendly
environment by the deployment of batteries for energy storage.

We are all dreaming of a better future with BoT (Battery of Things)
in which Samsung SDI will provide solutions for the world.

1970	2000	2008	2010
Established Samsung SDI	Began Lithium-ion Battery Business	Expanded Business into Automotives	Expanded Business into Energy Storage

Powering Tomorrow,
Samsung SDI Battery Solution for Energy Storage

Samsung SDI's technology supplies eco-friendly energy solutions for the present and the future.

We provide safe, reliable and long-lasting performance with our Energy Storage solutions.
ESS projects are deployed using Samsung SDI's battery solutions optimized for a range from residential to utility-scale projects.

Utility & Commercial Battery Platform

Optimized Battery Platforms Based on High-Density Design Technology

Solar & Wind Farm · Grid/Substation · Building, Factory

UPS Lithium-ion Solution

Proven High-Voltage LIB Solutions Compatible with Premium UPS

Data Center · Factory

Residential & Telecom Battery Pack Solution

Scalable Standard Battery Pack for Customized ESS

PV Home · Telecom

Why Samsung SDI

Samsung SDI optimizes battery systems with advanced cell technology.

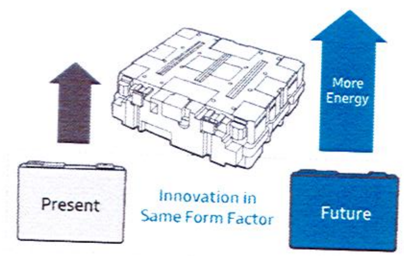
Safety First

Multi-Layered
Protection

Safety first is Samsung SDI priority. Prismatic cell has multi-layered protection at the cell level resulting in best in class safety. In addition, the aluminum exterior has excellent thermal conductivity and cooling performance, and it releases high temperature safely and efficiently from the inside to the outside.

Sustainable Design

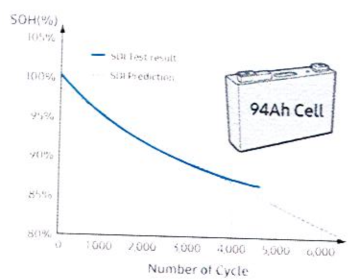
Easy to Upgrade
Capacity without
Design Change



We are continuously innovating to increase the energy density while maintaining the same form factor and cell dimensions, thus facilitating future upgrades to higher capacity, higher energy density, ESS with no change to pack design.

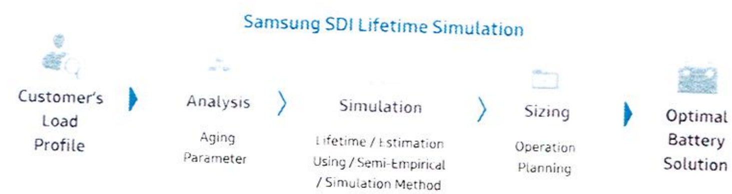
Long Cycle Life

Industry Leading Cycle Life Performance
6,000 Cycles
@continuous 1C/1C, SOH 80%



Samsung SDI ESS leverages our manufacturing experience in IT and automotive battery cells resulting in superior and adaptive technology.
Samsung SDI ESS is recognized as the industry leader in the market, providing our customers with the safest and long lasting batteries.

Accurate Lifetime Simulation



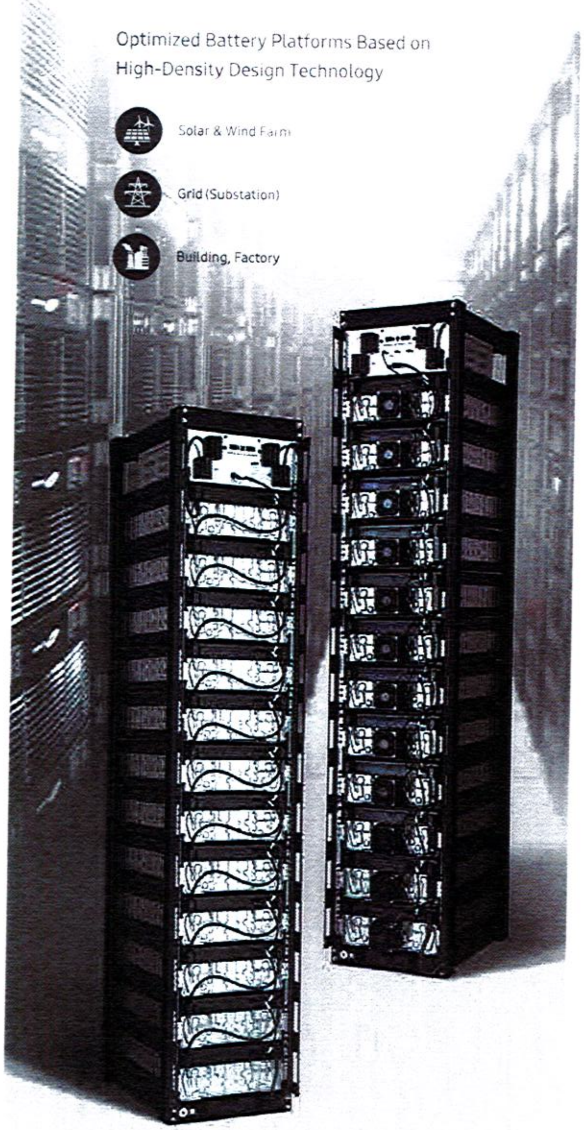
Samsung SDI offers optimal battery solution with its superior lifetime prediction technology.
We design and propose a battery system with analyzing the various parameter such as purpose, operation period and installation environment.

Battery Platform for

Utility & Commercial ESS

Optimized Battery Platforms Based on High-Density Design Technology

- Solar & Wind Farm
- Grid (Substation)
- Building, Factory

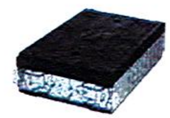


Standard Platform

Energy Platform New

Over 2 hours

- Energy density has increased more than 16% with upgrades to Samsung SDI's new advanced module
- Higher density enables better footprint and installation cost savings



Item		Module	Rack		
Model		ES-M088	ES-R168	ES-R203	ES-R221
Cell Capacity	Ah	100	100	100	100
Energy	kWh	8.8	168	203	221
Operating Voltage	V	58.4-49.8	730-946	883-1,145	960-1,245
Dimension (W x D x H)	mm	370 x 637 x 160	876 x 711 x 1,793	876 x 711 x 2,125	876 x 711 x 2,289
Weight	kg	61	1,268	1,523	1,650

Medium Platform

1 hour up to 45 minutes

- Unique Platform in the ESS Industry with Mid-range Capabilities
- Optimized Solution for around One hour of Grid Service
- The Highest Lifetime Performance in a Continuous Charge/Discharge for 1 hour

Item		Module	Rack		
Model		MS-M083	MS-R075	MS-R089	MS-R097
Cell Capacity	Ah	100	100	100	100
Energy	kWh	83	75	89	97
Operating Voltage	V	70.4-91.5	634-822	774-1,004	845-1,096
Dimension (W x D x H)	mm	370 x 650 x 160	438 x 711 x 1,791	438 x 711 x 2,125	438 x 711 x 2,289
Weight	kg	56	564	685	742

Power Platform

30 minutes up to 20 minutes

- High Power Platform Optimized for Less than 30 minutes of Use
- Optimized Solution for Power Applications such as F/R, Railway, Ship, etc.

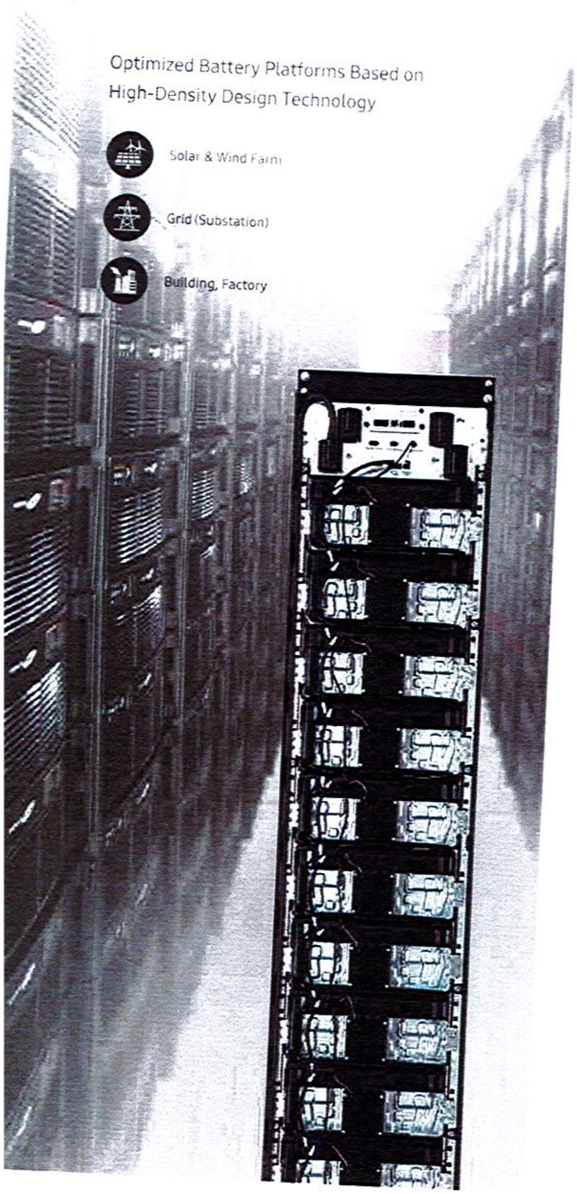
Item		Module	Rack		
Model		PS-M065	PS-R057	PS-R070	PS-R076
Cell Capacity	Ah	78	78	78	78
Energy	kWh	6.5	57	70	76
Operating Voltage	V	68.2-90.2	614-812	750-992	818-1,082
Dimension (W x D x H)	mm	370 x 650 x 160	438 x 711 x 1,791	438 x 711 x 2,125	438 x 711 x 2,289
Weight	kg	54	560	575	734

Battery Platform for

Utility & Commercial ESS

Optimized Battery Platforms Based on High-Density Design Technology

- Solar & Wind Farm
- Grid (Substation)
- Building, Factory



Special Platform

1,500 High Voltage Platform New

- High Efficiency Battery Solution for 1,500V PCS

Minimize Power Loss

by Enabling High PowerOutput

Minimize Total Footprint

by Reducing Footprint of PCS and Battery System

Maximize Economics & Efficiency

Product Lineup

Item		Rack		
Model		E3-R256	M3-R130	P3-R101
Platform		Energy	Medium	Power
Backup Time		2 hours	1 hour	30 minutes
Cell Capacity	Ah	100	100	78
Energy	kWh	256	130	101
Operating Voltage	V	1,114-1,444	1,326~1,461	1,091-1,443
Dimension (W x D x H)	mm	876 x 711 x 2,750	438 x 711 x 3,082	438 x 711 x 3,082
Weight	kg	1,929	1,001	965

Global Track Record

Since 2010, Samsung SDI's ESS products have been successfully operating in over 30 countries.

Today, Samsung SDI continues to make history by leading the growing global ESS market, based on best in class battery technology and strong partnerships.

SINCE
'10

COUNTRIES
30+

TOTAL GWh
10+

Americas

USA

California 150MWh Deployed 2017~

Austin, TX 36MW / 14MWh
El Cajon/Escondido, CA 37.5MW / 150MWh
Pomona, CA 20MW / 80MWh
Indianapolis, IN 20MW / 20MWh
El Centro, CA 30MW / 20MWh
Tucson, AZ 10MW / 5MWh
Punta Gorda, FL 10MW / 40MWh

Canada

Sault Sainte Marie, Ontario 8MW / 8MWh

Europe

Germany

Schwerin 15MWh Deployed 2014/17~

Schwerin 15MW / 15MWh
Chemnitz 10MW / 10MWh
Hassfurth 10MW / 10MWh

UK

Leighton Buzzard 10MWh Deployed 2014~

Leighton Buzzard 6MW / 10MWh
Barrow in Furness 49MW / 25MWh
Broxburn 20MW / 22MWh
Port of Tyne 36MW / 28MWh
Tynemouth 25MW / 17MWh
Pelham 50MW / 50MWh

Italy

Potenza 2MW / 2MWh

Netherlands

Zeeland 10MW / 10MWh

Spain

Carboneras 20MW / 12MWh

Asia & Oceania

Korea

KEPCO F/R 38MWh Deployed 2015~

KEPCO(5 Sites) 128MW / 38MWh
KOEN(3 Sites) 22MW / 63MWh
PyeongChang 6MW / 18MWh
Ulsan 24MW / 51MWh

China

Tibet 28MWh(2 Sites) Deployed 2016~

Tibet Shuanghu 4MW / 14MWh
Tibet Gaize 4MW / 14MWh

Japan

Hokkaido 25+MWh(3 Sites) Deployed 2017~

Hokkaido Shinhidaka 17MW / 9MWh
Hokkaido Chitose 17MW / 14MWh

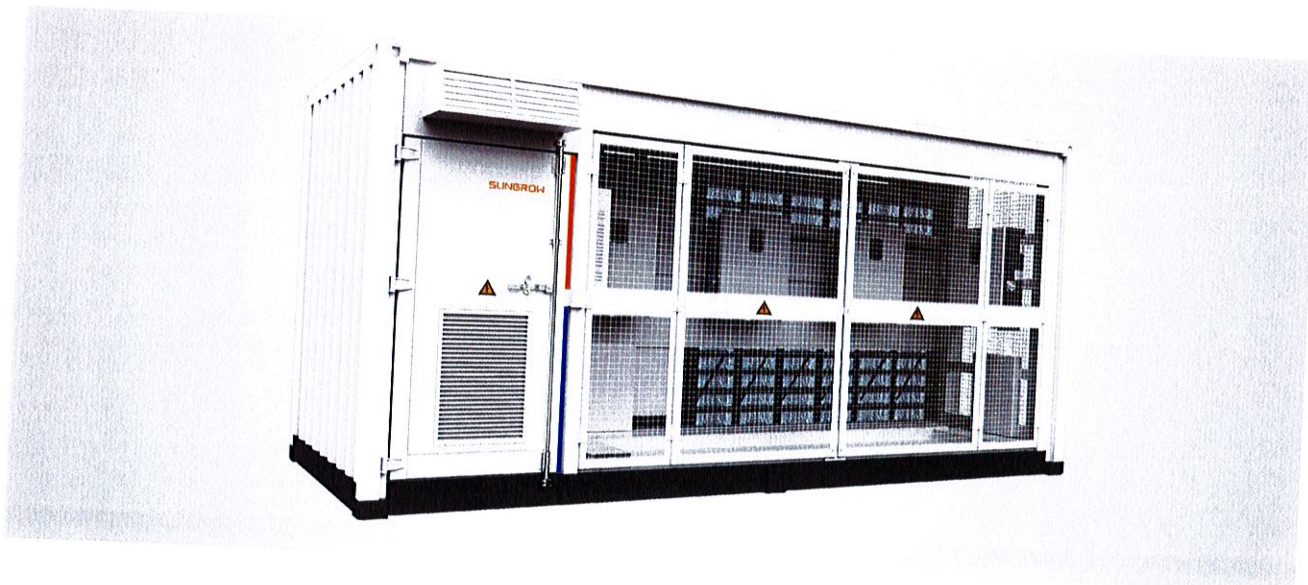
Australia

Alice Spring 6MW / 2MWh
Western Australia 4MW / 2MWh
Adelaide 30MW/15MWh

ST548KWH-D250HV +4xSG125HV

Storage System

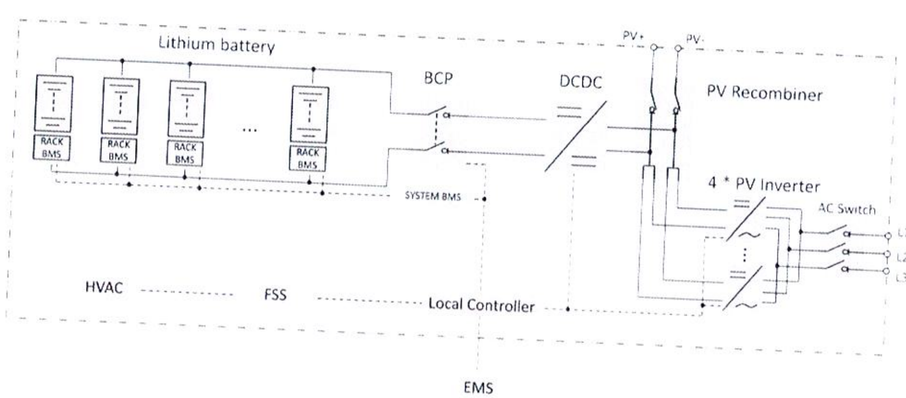
SUNGROW | SAMSUNG SAMSUNG SDI



SYSTEM FEATURES

- ESS system integrated with PV inverter
- 1500V DC coupled PV+ESS system
- Compact mechanical design,minimized footprint
- High efficient system with safe and long lifecycle lithiun-ion battery
- Integrated local controller, HVAC and FSS to enable unified communication and ensure system safety

CIRCUIT DIAGRAM



System Type	ST548KWH-D250HV+4xSG125HV
PV Data	
Max PV input voltage	1,500 V
MPPT voltage range at nominal power	860 ~ 1,250 V
Number of DC inputs	5
Max. PV input current	1,250 A
DCDC Data	
Working voltage range	500 ~ 1,500 V
Nominal power	250 KW
Max. current	344 A
Battery Data	
Cell type	Samsung SDI Mega E2, 3.68 V / 94 Ah
Configuration of system	264S6P
Battery capacity (BOL)	548 kWh
Battery voltage range	844 ~1,095 V
AC Data	
AC output power	500kVA @ 50 °C
Max. AC output current	480 A
Nominal AC voltage	3 / PE, 600 V
AC voltage range	480 ~ 690 V
Nominal grid frequency / Grid frequency range	60 Hz / 55 ~ 65 Hz
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading ~ 0.8 lagging
Feed-in phases / connection phases	3/3
General Data	
Dimensions (W * H * D)	6,058 * 2,896 * 2,438 mm / 238.5 * 114.0 * 96.0
Weight (with / without battery)	12.5 T / 8.6 T 27,558 lbs /18,960 lbs
Degree of protection	IP 54 / NEMA 3R
Operating temperature range	-30 to 50 °C / -22 to 122 °F
Relative humidity	0 ~ 95 % (non-condensing)
Max. working altitude	2,000 m / 6,562 ft
Cooling concept of battery chamber	Heating, Ventilation and Air Conditioning
Fire suppression system of battery unit	FM-200 extinguishment system
Communication interfaces	RS485, Ethernet
Communication protocols	Modbus RTU, Modbus TCP
Compliance	UL9540

APPLICATION

ANSUL

Power Generation

CHALLENGE:
Protecting sub-stations, electrical switch rooms, control rooms, data communications and other critical areas

SOLUTION:
ANSUL® FM-200™ Clean Agent Fire Suppression System

APPLICATION:
Protecting critical operational infrastructure in cramped conditions

Power stations and power generation facilities incorporate a wide range of critical and ancillary services and buildings to ensure continued operations and plant uptime. Away from the primary power circuit, boiler and turbine system; vital facilities such as sub-stations, cable voids, control rooms, data communications and backup systems must be effectively protected against fire risk. Selecting the right solution to protect this critical plant infrastructure is key.

The ANSUL FM-200 Clean Agent Fire Suppression System has zero ozone depletion potential (ODP). The system uses FM-200 (HFC-227ea) fire extinguishant which vaporizes upon discharge and absorbs heat to rapidly suppress fire. This results in less damage to critical equipment, facilitating a much shorter recovery time and reducing downtime. Safe for use in occupied areas at the design concentration, the system helps protect critical infrastructure and delivers effective asset protection for power generation facilities.

The ANSUL FM-200 system is most effective when used with the automatic AUTOPULSE Detection and Control System to introduce the clean agent rapidly. This detection system is used to actuate a single, fixed fire suppression or alarm system based on inputs received from fire detection devices. The detection circuits can be configured using cross, counting, independent or priority-zone concepts.

Both automatic and manual actuators are available for release of the agent into the hazard area through fixed piping and nozzles. Seven nozzle sizes are available to provide the correct flow of agent in either 180 or 360 horizontal discharge patterns. For large hazards, cylinders can be connected to a common manifold.

The ANSUL FM-200 system carries UL, FM and ULC, as well as marine approvals. The system can be designed to meet the requirements of EN 15004, ISO 14520 and NFPA 2001 with components approved to provide the highest quality fire suppression system.

tyco
Fire Protection Products

One Stanton Street / Marinette, WI 54143-2542, USA / +1-715-735-7411 / www.ansul.com
 / Form No. F-2015167

R227EA

A-Gas (U.S. Headquarters)

Chemwatch: **54078**
Version No: **6.1.10.9**
Safety Data Sheet according to OSHA HazCom Standard (2012) requirements

Chemwatch Hazard Alert Code: 1

Issue Date: **09/09/2018**
Print Date: **16/08/2021**
L.GHS.USA.EN

SECTION 1 Identification

Product Identifier

Product name	R227EA
Chemical Name	1,1,1,2,3,3,3-heptafluoropropane
Synonyms	F7-C3-H; HFC-227ea; Halon 37; halogenated alkane fire extinguishing agent; FM-200
Proper shipping name	Heptafluoropropane or Refrigerant gas R 227
Chemical formula	C3HF7
Other means of identification	Not Available
CAS number	431-89-0

Recommended use of the chemical and restrictions on use

Relevant identified uses	Fire extinguishing agent for use in total flooding application. Hydrofluorocarbons (HFCs) are organic compounds that contain fluorine and hydrogen atoms, and are the most common type of organofluorine compounds. They are frequently used in air conditioning and as refrigerants in place of the older chlorofluorocarbons. Fluorocarbons with few C–F bonds behave similarly to the parent hydrocarbons, but their reactivity can be altered significantly. Packed as liquid under pressure and remains liquid only under pressure.

Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party

Registered company name	A-Gas (U.S. Headquarters)
Address	1100 Haskins Rd. Bowling Green, OH 43402 United States
Telephone	14198678990
Fax	1-419-867-3279
Website	www.agasamericas.com
Email	tammy.myers@agas.com

Emergency phone number

Association / Organisation	PERS
Emergency telephone numbers	1-800-633-8253
Other emergency telephone numbers	International 1-801-629-0667

SECTION 2 Hazard(s) identification

Classification of the substance or mixture

NFPA 704 diamond

Note: The hazard category numbers found in GHS classification in section 2 of this SDSs are NOT to be used to fill in the NFPA 704 diamond. Blue = Health Red = Fire Yellow = Reactivity White = Special (Oxidizer or water reactive substances)

Classification	Gases Under Pressure (Liquefied Gas)

Label elements

Hazard pictogram(s) 

Signal word **Warning**

Hazard statement(s)

H280	Contains gas under pressure; may explode if heated.

Hazard(s) not otherwise classified

Not Applicable

Precautionary statement(s) General

P101	If medical advice is needed, have product container or label at hand.
P102	Keep out of reach of children.
P103	Read label before use.

Precautionary statement(s) Prevention

Not Applicable

Precautionary statement(s) Response

Not Applicable

Precautionary statement(s) Storage

P410+P403	Protect from sunlight. Store in a well-ventilated place.

Precautionary statement(s) Disposal

Not Applicable

SECTION 3 Composition / information on ingredients

Substances

CAS No	%[weight]	Name
431-89-0	100	R227ea

Mixtures

See section above for composition of Substances

SECTION 4 First-aid measures

Description of first aid measures

Eye Contact

- If product comes in contact with eyes remove the patient from gas source or contaminated area.
- Take the patient to the nearest eye wash, shower or other source of clean water.
- Open the eyelid(s) wide to allow the material to evaporate.
- Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners.
- The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage.
- Ensure that the patient looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s)
- Transport to hospital or doctor.
- Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur.
- If the patient cannot tolerate light, protect the eyes with a clean, loosely tied bandage.
- Ensure verbal communication and physical contact with the patient.

DO NOT allow the patient to rub the eyes
DO NOT allow the patient to tightly shut the eyes
DO NOT introduce oil or ointment into the eye(s) without medical advice
DO NOT use hot or tepid water.

Skin Contact

If skin contact occurs:

- Immediately remove all contaminated clothing, including footwear.
- Flush skin and hair with running water (and soap if available).
- Seek medical attention in event of irritation.

In case of cold burns (frost-bite):

- Move casualty into warmth before thawing the affected part; if feet are affected carry if possible
- Bathe the affected area immediately in luke-warm water (not more than 35 deg C) for 10 to 15 minutes, immersing if possible and

		without rubbing - **DO NOT** apply hot water or radiant heat. - Apply a clean, dry, light dressing of "fluffed-up" dry gauze bandage - If a limb is involved, raise and support this to reduce swelling - If an adult is involved and where intense pain occurs provide pain killers such as paracetomol - Transport to hospital, or doctor - Subsequent blackening of the exposed tissue indicates potential of necrosis, which may require amputation.
Inhalation		- Following exposure to gas, remove the patient from the gas source or contaminated area. - NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer. - Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures. - If the patient is not breathing spontaneously, administer rescue breathing. - If the patient does not have a pulse, administer CPR. - If medical oxygen and appropriately trained personnel are available, administer 100% oxygen. - Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Centre for further instruction. - Keep the patient warm, comfortable and at rest while awaiting medical care. - **MONITOR THE BREATHING AND PULSE, CONTINUOUSLY.** - Administer rescue breathing (preferably with a demand-valve resuscitator, bag-valve mask-device, or pocket mask as trained) or CPR if necessary.
Ingestion		- Not considered a normal route of entry. - For advice, contact a Poisons Information Centre or a doctor. - Avoid giving milk or oils. - Avoid giving alcohol.

Most important symptoms and effects, both acute and delayed

See Section 11

Indication of any immediate medical attention and special treatment needed

for intoxication due to Freons/ Halons;

A: Emergency and Supportive Measures

- Maintain an open airway and assist ventilation if necessary
- Treat coma and arrhythmias if they occur. Avoid (adrenaline) epinephrine or other sympathomimetic amines that may precipitate ventricular arrhythmias. Tachyarrhythmias caused by increased myocardial sensitisation may be treated with propranolol, 1-2 mg IV or esmolol 25-100 microgm/kg/min IV.
- Monitor the ECG for 4-6 hours

B: Specific drugs and antidotes:

- There is no specific antidote

C: Decontamination

- Inhalation; remove victim from exposure, and give supplemental oxygen if available.
- Ingestion; (a) Prehospital: Administer activated charcoal, if available. **DO NOT** induce vomiting because of rapid absorption and the risk of abrupt onset CNS depression. (b) Hospital: Administer activated charcoal, although the efficacy of charcoal is unknown. Perform gastric lavage only if the ingestion was very large and recent (less than 30 minutes)

D: Enhanced elimination:

- There is no documented efficacy for diuresis, haemodialysis, haemoperfusion, or repeat-dose charcoal.

POISONING and DRUG OVERDOSE, Californian Poison Control System Ed. Kent R Olson; 3rd Edition

- Do not administer sympathomimetic drugs unless absolutely necessary as material may increase myocardial irritability.
- No specific antidote.
- Because rapid absorption may occur through lungs if aspirated and cause systematic effects, the decision of whether to induce vomiting or not should be made by an attending physician.
- If lavage is performed, suggest endotracheal and/or esophageal control.
- Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach.
- Treatment based on judgment of the physician in response to reactions of the patient

For frost-bite caused by liquefied petroleum gas:

- If part has not thawed, place in warm water bath (41-46 C) for 15-20 minutes, until the skin turns pink or red.
- Analgesia may be necessary while thawing.
- If there has been a massive exposure, the general body temperature must be depressed, and the patient must be immediately rewarmed by whole-body immersion, in a bath at the above temperature.
- Shock may occur during rewarming.
- Administer tetanus toxoid booster after hospitalization.
- Prophylactic antibiotics may be useful.
- The patient may require anticoagulants and oxygen.

[Shell Australia 22/12/87]

For gas exposures:

BASIC TREATMENT

- Establish a patent airway with suction where necessary.
- Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- Administer oxygen by non-rebreather mask at 10 to 15 l/min.
- Monitor and treat, where necessary, for pulmonary oedema .
- Monitor and treat, where necessary, for shock.
- Anticipate seizures.

ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- Positive-pressure ventilation using a bag-valve mask might be of use.
- Monitor and treat, where necessary, for arrhythmias.
- Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- Drug therapy should be considered for pulmonary oedema.
- Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- Treat seizures with diazepam.
- Proparacaine hydrochloride should be used to assist eye irrigation.

BRONSTEIN, A.C. and CURRANCE, P.L.

EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994

SECTION 5 Fire-fighting measures

Extinguishing media

SMALL FIRE: Use extinguishing agent suitable for type of surrounding fire.

LARGE FIRE: Cool cylinder.

DO NOT direct water at source of leak or venting safety devices as icing may occur.

Special hazards arising from the substrate or mixture

Fire Incompatibility	Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result

Special protective equipment and precautions for fire-fighters

Fire Fighting	GENERAL - Alert Fire Brigade and tell them location and nature of hazard. - Wear breathing apparatus and protective gloves. - Fight fire from a safe distance, with adequate cover. - Use water delivered as a fine spray to control fire and cool adjacent area.
Fire/Explosion Hazard	- Containers may explode when heated - Ruptured cylinders may rocket - Fire exposed containers may vent contents through pressure relief devices. - High concentrations of gas may cause asphyxiation without warning. - May decompose explosively when heated or involved in fire. - Contact with gas may cause burns, severe injury and/ or frostbite. Decomposition may produce toxic fumes of: carbon monoxide (CO) carbon dioxide (CO2) hydrogen fluoride other pyrolysis products typical of burning organic material. **Contains low boiling substance:** Closed containers may rupture due to pressure buildup under fire conditions.

SECTION 6 Accidental release measures

Personal precautions, protective equipment and emergency procedures

See section 8

Environmental precautions

See section 12

Methods and material for containment and cleaning up

Minor Spills	- Avoid breathing vapour and any contact with liquid or gas. Protective equipment including respirator should be used. - **DO NOT** enter confined spaces where gas may have accumulated. - Increase ventilation.
Major Spills	- Clear area of all unprotected personnel and move upwind. - Alert Emergency Authority and advise them of the location and nature of hazard. - Wear breathing apparatus and protective gloves. - Prevent by any means available, spillage from entering drains and water-courses. - Remove leaking cylinders to a safe place. - Fit vent pipes. Release pressure under safe, controlled conditions - Burn issuing gas at vent pipes. - **DO NOT** exert excessive pressure on valve; **DO NOT** attempt to operate damaged valve.

Personal Protective Equipment advice is contained in Section 8 of the SDS.

SECTION 7 Handling and storage

Precautions for safe handling

Safe handling

-Consider use in closed pressurised systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature
-The tubing network design connecting gas cylinders to the delivery system should include appropriate pressure indicators and vacuum or suction lines.
-Fully-welded types of pressure gauges, where the bourdon tube sensing element is welded to the gauge body, are recommended.
-Before connecting gas cylinders, ensure manifold is mechanically secure and does not containing another gas.

- **DO NOT** transfer gas from one cylinder to another.

Other information

-Do NOT store halogenated aliphatics in areas containing alkali or alkaline earth metals such as powdered aluminum, zinc, or beryllium

- Store below 38 deg. C.
- Cylinders should be stored in a purpose-built compound with good ventilation, preferably in the open.
- Such compounds should be sited and built in accordance with statutory requirements.
- The storage compound should be kept clear and access restricted to authorised personnel only.
- Cylinders stored in the open should be protected against rust and extremes of weather.

Conditions for safe storage, including any incompatibilities

Suitable container

- **DO NOT** use aluminium or galvanised containers
- Cylinder:
- Ensure the use of equipment rated for cylinder pressure.
- Ensure the use of compatible materials of construction.
- Valve protection cap to be in place until cylinder is secured, connected.
- Cylinder must be properly secured either in use or in storage.

Storage incompatibility

Haloalkanes:

- are highly reactive:some of the more lightly substituted lower members are highly flammable; the more highly substituted may be used as fire suppressants, not always with the anticipated results.
- may react with the lighter divalent metals to produce more reactive compounds analogous to Grignard reagents.
- may produce explosive compounds following prolonged contact with metallic or other azides
- may react on contact with potassium or its alloys - although apparently stable on contact with a wide rage of halocarbons, reaction products may be shock-sensitive and may explode with great violence on light impact; severity generally increases with the degree of halocarbon substitution and potassium-sodium alloys give extremely sensitive mixtures .

BRETHERICK L.: Handbook of Reactive Chemical Hazards

- react with metal halides and active metals, eg. sodium (Na), potassium (K), lithium (Li),calcium (Ca), zinc (Zn), powdered aluminium (Al) and aluminium alloys, magnesium (Mg) and magnesium alloys.

As a general rule, hydrofluorocarbons tend to be flammable unless they contain more fluorine atoms than hydrogen atoms.

- Compressed gases may contain a large amount of kinetic energy over and above that potentially available from the energy of reaction produced by the gas in chemical reaction with other substances

SECTION 8 Exposure controls / personal protection

Control parameters

Occupational Exposure Limits (OEL)

INGREDIENT DATA

Not Available

Emergency Limits

Ingredient	TEEL-1	TEEL-2	TEEL-3
R227EA	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
R227ea	Not Available	Not Available

MATERIAL DATA

Sensory irritants are chemicals that produce temporary and undesirable side-effects on the eyes, nose or throat. Historically occupational exposure standards for these irritants have been based on observation of workers' responses to various airborne concentrations. Present day expectations require that nearly every individual should be protected against even minor sensory irritation and exposure standards are established using uncertainty factors or safety factors of 5 to 10 or more. On occasion animal no-observable-effect-levels (NOEL) are used to determine these limits where human results are unavailable.

Exposure controls

Appropriate engineering controls

Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
The basic types of engineering controls are:
Process controls which involve changing the way a job activity or process is done to reduce the risk.
Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.

Personal protection

Eye and face protection

- Chemical goggles.
- Full face shield may be required for supplementary but never for primary protection of eyes.
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.

Skin protection

See Hand protection below

Hands/feet protection

- Butyl rubber gloves
  Butyl rubber gloves should be used when handling halogenated aliphatics .
  ·Nitrile, PVC-coated nitrile, and PVC protective equipment are not recommended
- Neoprene gloves
- Polyethylene gloves
- When handling sealed and suitably insulated cylinders wear cloth or leather gloves.
- Insulated gloves:

NOTE: Insulated gloves should be loose fitting so that may be removed quickly if liquid is spilled upon them. Insulated gloves are not made to permit hands to be placed in the liquid; they provide only short-term protection from accidental contact with the liquid.

Body protection

See Other protection below

Other protection

·Halogen-selective detectors use a specialized sensor that allows the monitor to detect compounds containing fluorine, chlorine, bromine, and iodine with-out interference from other species.These detectors are typically easy to use, feature higher sensitivity than the nonselective detectors (detection limits are typically <5 ppm when used as an area monitor and <1.4 gm/yr [<0.05 oz/yr] when used as a leak pinpointer).

·Compound-Specific Detectors are typically capable of detecting the presence of a single compound without interference from other compounds.

- Protective overalls, closely fitted at neck and wrist.
- Eye-wash unit.
- Ensure availability of lifeline in confined spaces.
- Staff should be trained in all aspects of rescue work.

Respiratory protection

Type AX Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Selection of the Class and Type of respirator will depend upon the level of breathing zone contaminant and the chemical nature of the contaminant. Protection Factors (defined as the ratio of contaminant outside and inside the mask) may also be important.

Required minimum protection factor	Maximum gas/vapour concentration present in air p.p.m. (by volume)	Half-face Respirator	Full-Face Respirator
up to 10	1000	AX-AUS / Class1	-
up to 50	1000	-	AX-AUS / Class 1
up to 50	5000	Airline *	-
up to 100	5000	-	AX-2
up to 100	10000	-	AX-3
100+			Airline**

* - Continuous Flow ** - Continuous-flow or positive pressure demand

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO_2), G = Agricultural chemicals, K = Ammonia(NH_3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

- Cartridge respirators should never be used for emergency ingress or in areas of unknown vapour concentrations or oxygen content.
- The wearer must be warned to leave the contaminated area immediately on detecting any odours through the respirator. The odour may indicate that the mask is not functioning properly, that the vapour concentration is too high, or that the mask is not properly fitted. Because of these limitations, only restricted use of cartridge respirators is considered appropriate.
- Cartridge performance is affected by humidity. Cartridges should be changed after 2 hr of continuous use unless it is determined that the humidity is less than 75%, in which case, cartridges can be used for 4 hr. Used cartridges should be discarded daily, regardless of the length of time used
- Positive pressure, full face, air-supplied breathing apparatus should be used for work in enclosed spaces if a leak is suspected or the primary containment is to be opened (e.g. for a cylinder change)
- Air-supplied breathing apparatus is required where release of gas from primary containment is either suspected or demonstrated.

SECTION 9 Physical and chemical properties

Information on basic physical and chemical properties

Appearance: Colourless, odourless compressed gas; does not mix with water.

Physical state	Liquified Gas	**Relative density (Water = 1)**	1.46
Odour	Not Available	**Partition coefficient n-octanol / water**	Not Available
Odour threshold	Not Available	**Auto-ignition temperature (°C)**	Not Applicable
pH (as supplied)	Not Applicable	**Decomposition temperature**	Not Available

Melting point / freezing point (°C)	-131
Initial boiling point and boiling range (°C)	-16.4
Flash point (°C)	Not Applicable
Evaporation rate	Not Available
Flammability	Not Applicable
Upper Explosive Limit (%)	Not Applicable
Lower Explosive Limit (%)	Not Applicable
Vapour pressure (kPa)	404.32 @ 21 C
Solubility in water	Immiscible
Vapour density (Air = 1)	Not Available
Viscosity (cSt)	Not Available
Molecular weight (g/mol)	170.03
Taste	Not Available
Explosive properties	Not Available
Oxidising properties	Not Available
Surface Tension (dyn/cm or mN/m)	Not Available
Volatile Component (%vol)	100
Gas group	Not Available
pH as a solution (%)	Not Applicable
VOC g/L	Not Available

SECTION 10 Stability and reactivity

Reactivity	See section 7
Chemical stability	‣ Unstable in the presence of incompatible materials. ‣ Product is considered stable. ‣ Hazardous polymerisation will not occur.
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 Toxicological information

Information on toxicological effects

Inhaled

Inhalation of vapours may cause drowsiness and dizziness. This may be accompanied by narcosis, reduced alertness, loss of reflexes, lack of coordination and vertigo.

Inhalation of vapours or aerosols (mists, fumes), generated by the material during the course of normal handling, may be damaging to the health of the individual.

Limited evidence or practical experience suggests that the material may produce irritation of the respiratory system, in a significant number of individuals, following inhalation. In contrast to most organs, the lung is able to respond to a chemical insult by first removing or neutralising the irritant and then repairing the damage. The repair process, which initially evolved to protect mammalian lungs from foreign matter and antigens, may however, produce further lung damage resulting in the impairment of gas exchange, the primary function of the lungs. Respiratory tract irritation often results in an inflammatory response involving the recruitment and activation of many cell types, mainly derived from the vascular system.

Exposure to high concentrations of fluorocarbons may produce cardiac arrhythmias or cardiac arrest due sensitisation of the heart to adrenalin or noradrenalin. Deaths associated with exposures to fluorocarbons (specifically halogenated aliphatics) have occurred in occupational settings and in inhalation of bronchodilator drugs.

Bronchospasm consistently occurs in human subjects inhaling fluorocarbons. At a measured concentration of 1700 ppm of one of the commercially available aerosols there is a biphasic change in ventilatory capacity, the first reduction occurring within a few minutes and the second delayed up to 30 minutes.

Common, generalised symptoms associated with non-toxic gas inhalation include :

- central nervous system effects such as headache, confusion, dizziness, progressive stupor, coma and seizures;
- respiratory system complications may include tachypnoea and dyspnoea;
- cardiovascular effects may include circulatory collapse and arrhythmias;
- gastrointestinal effects may also be present and may include mucous membrane irritation and nausea and vomiting.

Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident, a single organ alone is (almost) never involved.

Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin)

Material is highly volatile and may quickly form a concentrated atmosphere in confined or unventilated areas. The vapour may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure.

The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.

Ingestion

Overexposure is unlikely in this form.

Not normally a hazard due to physical form of product.

Considered an unlikely route of entry in commercial/industrial environments

Skin Contact

Prolonged or widespread skin contact with the liquid may result in the absorption of harmful amounts of material.

Repeated exposure may cause skin cracking, flaking or drying following normal handling and use.

Skin contact with the material may damage the health of the individual; systemic effects may result following absorption.

Limited evidence exists, or practical experience predicts, that the material either produces inflammation of the skin in a substantial number of individuals following direct contact, and/or produces significant inflammation when applied to the healthy intact skin of animals, for up to four hours, such inflammation being present twenty-four hours or more after the end of the exposure period. Skin irritation may also be present after prolonged or repeated exposure; this may result in a form of contact dermatitis (nonallergic). The dermatitis is often characterised by skin redness (erythema) and swelling (oedema) which may progress to blistering (vesiculation), scaling and thickening of the epidermis. At the microscopic level there may be intercellular oedema of the spongy layer of the skin (spongiosis) and intracellular oedema of the epidermis.

In common with other halogenated aliphatics, fluorocarbons may cause dermal problems due to a tendency to remove natural oils from the skin causing irritation and the development of dry, sensitive skin. They do not appear to be appreciably absorbed.
Open cuts, abraded or irritated skin should not be exposed to this material
Material on the skin evaporates rapidly and may cause tingling, chilling and even temporary numbness
Entry into the blood-stream through, for example, cuts, abrasions, puncture wounds or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Vapourising liquid causes rapid cooling and contact may cause cold burns, frostbite, even through normal gloves. Frozen skin tissues are painless and appear waxy and yellow. Signs and symptoms of frost-bite may include "pins and needles", paleness followed by numbness, a hardening an stiffening of the skin, a progression of colour changes in the affected area, (first white, then mottled and blue and eventually black; on recovery, red, hot, painful and blistered).

Eye

Although the material is not thought to be an irritant (as classified by EC Directives), direct contact with the eye may produce transient discomfort characterised by tearing or conjunctival redness (as with windburn).
Direct contact with the eye may not cause irritation because of the extreme volatility of the gas; however concentrated atmospheres may produce irritation after brief exposures..

Chronic

Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.

It is generally accepted that the fluorocarbons are less toxic than the corresponding halogenated aliphatic based on chlorine. Repeated inhalation exposure to the fluorocarbon FC-11 does not produce pathologic lesions of the liver and other visceral organs in experimental animals. There has been conjecture in non-scientific publications that fluorocarbons may cause leukemia, cancer, sterility and birth defects; these have not been verified by current research. The high incidence of cancer, spontaneous abortion and congenital anomalies amongst hospital personnel, repeatedly exposed to fluorine-containing general anaesthetics, has caused some scientists to call for a lowering of the fluorocarbon exposure standard to 5 ppm since some are mutagens.
Principal route of occupational exposure to the gas is by inhalation.

	TOXICITY	IRRITATION
R227ea	Inhalation(Rat) LC50; >788696 ppm4h[1]	Not Available

Legend: *1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances*

R227EA

Disinfection by products (DBPs) re formed when disinfectants such as chlorine, chloramine, and ozone react with organic and inorganic matter in water. The observations that some DBPs such as trihalomethanes (THMs), di-/trichloroacetic acids, and 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) are carcinogenic in animal studies have raised public concern over the possible adverse health effects of DBPs. To date, several hundred DBPs have been identified.
Numerous haloalkanes and haloalkenes have been tested for carcinogenic and mutagenic activities. n general, the genotoxic potential is dependent on the nature, number, and position of halogen(s) and the molecular size of the compound.

Acute Toxicity	✗	**Carcinogenicity**	✗
Skin Irritation/Corrosion	✗	**Reproductivity**	✗
Serious Eye Damage/Irritation	✗	**STOT - Single Exposure**	✗
Respiratory or Skin sensitisation	✗	**STOT - Repeated Exposure**	✗
Mutagenicity	✗	**Aspiration Hazard**	✗

Legend: ✗ *– Data either not available or does not fill the criteria for classification*
✔ *– Data available to make classification*

SECTION 12 Ecological information

Toxicity

	Endpoint	Test Duration (hr)	Species	Value	Source
R227ea	NOEC(ECx)	96h	Fish	10mg/l	2
	EC50	72h	Algae or other aquatic plants	>114mg/l	2
	LC50	96h	Fish	>81.8mg/l	2
	EC50	48h	Crustacea	>97.9mg/l	2

Legend: *Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 (QSAR) - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data*

HFCs (hydrofluorocarbons) have been widely used as replacements for Ozone Depletion Substances (ODSs.) Because they do not contain chlorine or bromine, they have an ozone Depletion Potential (ODP) of 0. However, certain HFCs have high Global warming Potential (GWPs). Perfluorinated fluorocarbons (PFCs) have extremely high GWPs and long atmospheric lifetimes. They do not deplete stratospheric ozone, but the U.S. Environmental Protection Agency (EPA) is concerned about their impact on global warming.
90halkane
In addition to carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), the greenhouse gases mentioned in the Kyoto Protocol include synthetic substances that share the common feature of being highly persistent in the atmosphere and exhibiting very high specific radiative forcing (radiative forcing is the change in the balance between radiation coming into the atmosphere and radiation out; a positive radiative forcing tends on average to warm the surface of the earth). These synthetic substances include hydrocarbons that are partially fluorinated (HCFs) or totally fluorinated (PFCs) as well as sulfur hexafluoride (SF6).
The greenhouse potential of these substances, expressed as multiples of that of CO2, are within the range of 140 to 11,700 for HFCs, from 6500 to 9,200 for PFCs and 23,900 for SF6. Once emitted into the atmosphere, these substances have an impact on the environment for decades, centuries, or in certain instances, for thousands of years.
DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
R227ea	HIGH	HIGH

Bioaccumulative potential

Ingredient	Bioaccumulation
R227ea	LOW (LogKOW = 2.5133)

Mobility in soil

Ingredient	Mobility
R227ea	LOW (KOC = 680.2)

SECTION 13 Disposal considerations

Waste treatment methods

Product / Packaging disposal

- Evaporate residue at an approved site.
- Return empty containers to supplier. If containers are marked non-returnable establish means of disposal with manufacturer prior to purchase.
- Ensure damaged or non-returnable cylinders are gas-free before disposal.

SECTION 14 Transport information

Labels Required

Marine Pollutant NO

Land transport (DOT)

UN number	3296
UN proper shipping name	Heptafluoropropane or Refrigerant gas R 227
Transport hazard class(es)	Class 2.2 Subrisk Not Applicable
Packing group	Not Applicable
Environmental hazard	Not Applicable
Special precautions for user	Hazard Label 2.2 Special provisions T50

Air transport (ICAO-IATA / DGR)

UN number	3296
UN proper shipping name	Refrigerant gas R 227; Heptafluoropropane
Transport hazard class(es)	ICAO/IATA Class 2.2 ICAO / IATA Subrisk Not Applicable ERG Code 2L

Packing group	Not Applicable
Environmental hazard	Not Applicable
Special precautions for user	Special provisions: Not Applicable Cargo Only Packing Instructions: 200 Cargo Only Maximum Qty / Pack: 150 kg Passenger and Cargo Packing Instructions: 200 Passenger and Cargo Maximum Qty / Pack: 75 kg Passenger and Cargo Limited Quantity Packing Instructions: Forbidden Passenger and Cargo Limited Maximum Qty / Pack: Forbidden

Sea transport (IMDG-Code / GGVSee)

UN number	3296
UN proper shipping name	HEPTAFLUOROPROPANE (REFRIGERANT GAS R 227)
Transport hazard class(es)	IMDG Class: 2.2 IMDG Subrisk: Not Applicable
Packing group	Not Applicable
Environmental hazard	Not Applicable
Special precautions for user	EMS Number: F-C , S-V Special provisions: Not Applicable Limited Quantities: 120 mL

Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

Transport in bulk in accordance with MARPOL Annex V and the IMSBC Code

Product name	Group
R227ea	Not Available

Transport in bulk in accordance with the ICG Code

Product name	Ship Type
R227ea	Not Available

SECTION 15 Regulatory information

Safety, health and environmental regulations / legislation specific for the substance or mixture

R227ea is found on the following regulatory lists

US Toxic Substances Control Act (TSCA) - Chemical Substance Inventory

US TSCA Chemical Substance Inventory - Interim List of Active Substances

Federal Regulations

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Section 311/312 hazard categories

Flammable (Gases, Aerosols, Liquids, or Solids)	No
Gas under pressure	Yes
Explosive	No
Self-heating	No
Pyrophoric (Liquid or Solid)	No
Pyrophoric Gas	No
Corrosive to metal	No
Oxidizer (Liquid, Solid or Gas)	No
Organic Peroxide	No
Self-reactive	No
In contact with water emits flammable gas	No
Combustible Dust	No
Carcinogenicity	No
	No

Acute toxicity (any route of exposure)	No
Reproductive toxicity	No
Skin Corrosion or Irritation	No
Respiratory or Skin Sensitization	No
Serious eye damage or eye irritation	No
Specific target organ toxicity (single or repeated exposure)	No
Aspiration Hazard	No
Germ cell mutagenicity	No
Simple Asphyxiant	No
Hazards Not Otherwise Classified	No

US. EPA CERCLA Hazardous Substances and Reportable Quantities (40 CFR 302.4)

None Reported

State Regulations

US. California Proposition 65

None Reported

National Inventory Status

National Inventory	Status
Australia - AIIC / Australia Non-Industrial Use	Yes
Canada - DSL	Yes
Canada - NDSL	No (R227ea)
China - IECSC	Yes
Europe - EINEC / ELINCS / NLP	Yes
Japan - ENCS	Yes
Korea - KECI	Yes
New Zealand NZIoC	Yes
Philippines - PICCS	Yes
USA - TSCA	Yes
Taiwan - TCSI	Yes
Mexico - INSQ	Yes
Vietnam - NCI	Yes
Russia - FBEPH	Yes

Legend: *Yes = All CAS declared ingredients are on the inventory*
No = One or more of the CAS listed ingredients are not on the inventory. These ingredients may be exempt or will require registration.

SECTION 16 Other information

Revision Date	09/09/2018
Initial Date	04/10/2003

SDS Version Summary

Version	Date of Update	Sections Updated
5.1.2.1	15/04/2009	Acute Health (eye), Acute Health (skin), Advice to Doctor, Disposal, Fire Fighter (fire/explosion hazard), Fire Fighter (fire incompatibility), First Aid (eye), First Aid (skin), Personal Protection (Respirator), Personal Protection (eye), Personal Protection (hands/feet), Physical Properties, Storage (storage incompatibility)
6.1.2.1	09/09/2018	Acute Health (eye), Acute Health (inhaled), Acute Health (skin), Advice to Doctor, Classification, Environmental, Exposure Standard, Fire Fighter (fire/explosion hazard), Personal Protection (other), Personal Protection (Respirator), Personal Protection (hands/feet), Physical Properties, Storage (storage incompatibility), Storage (storage requirement), Supplier Information, Synonyms, Toxicity and Irritation (Other), Use
6.1.3.1	10/05/2021	Regulation Change
6.1.4.1	24/05/2021	Regulation Change
6.1.4.2	30/05/2021	Template Change
6.1.4.3	04/06/2021	Template Change
6.1.4.4	05/06/2021	Template Change
6.1.4.5	09/06/2021	Template Change

Version	Date of Update	Sections Updated
6.1.4.6	11/06/2021	Template Change
6.1.4.7	15/06/2021	Template Change
6.1.4.8	05/07/2021	Template Change
6.1.5.8	14/07/2021	Regulation Change
6.1.6.8	15/07/2021	Regulation Change
6.1.6.9	01/08/2021	Template Change
6.1.7.9	02/08/2021	Regulation Change
6.1.8.9	05/08/2021	Regulation Change
6.1.9.9	09/08/2021	Regulation Change
6.1.10.9	16/08/2021	Regulation Change

Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average
PC—STEL: Permissible Concentration-Short Term Exposure Limit
IARC: International Agency for Research on Cancer
ACGIH: American Conference of Governmental Industrial Hygienists
STEL: Short Term Exposure Limit
TEEL: Temporary Emergency Exposure Limit。
IDLH: Immediately Dangerous to Life or Health Concentrations
ES: Exposure Standard
OSF: Odour Safety Factor
NOAEL :No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level
TLV: Threshold Limit Value
LOD: Limit Of Detection
OTV: Odour Threshold Value
BCF: BioConcentration Factors
BEI: Biological Exposure Index
AIIC: Australian Inventory of Industrial Chemicals
DSL: Domestic Substances List
NDSL: Non-Domestic Substances List
IECSC: Inventory of Existing Chemical Substance in China
EINECS: European INventory of Existing Commercial chemical Substances
ELINCS: European List of Notified Chemical Substances
NLP: No-Longer Polymers
ENCS: Existing and New Chemical Substances Inventory
KECI: Korea Existing Chemicals Inventory
NZIoC: New Zealand Inventory of Chemicals
PICCS: Philippine Inventory of Chemicals and Chemical Substances
TSCA: Toxic Substances Control Act
TCSI: Taiwan Chemical Substance Inventory
INSQ: Inventario Nacional de Sustancias Quimicas
NCI: National Chemical Inventory
FBEPH: Russian Register of Potentially Hazardous Chemical and Biological Substances

Envirotemp™ 360 fluid

Synthetic Ester Fluid

Product Description

Envirotemp 360 fluid is a less flammable dielectric liquid ideally suited for use in free-breathing transformers (both new and retrofill) and is also proven in traction transformers. Envirotemp 360 fluid has been thoroughly evaluated and conforms to IEC 61099 "Specifications for Unused Synthetic Organic Esters for Electrical Purposes."

Advantages

- The high fire point (315°C vs 160°C for mineral oil) allows its classification as a K-Class, less flammable liquid.
- It is a high thermal class dielectric liquid, suitable for use in free-breathing applications.
- It continues to flow even in extremely cold climates.
- Envirotemp 360 fluid is optimized for oxidative stability. It surpasses the required performance of the oxidative stability test of synthetic ester liquids[a] even when tested for a period almost 5x longer.
- It is readily biodegradable according to OECD 301B and not classified as hazardous according to GHS.

Envirotemp™ 360 fluid values and specification units

PROPERTY	TEST METHOD	IEC 61099 PERMISSIBLE VALUES	TYPICAL
PHYSICAL			
Color	ISO 2211	≤ 200 Hazen	≤ 100 Hazen
	ISO 2049		0.1
Appearance	Visually clear, free from water, suspended matter and sediment		
Density at 20°C (kg/dm³)	ISO 3675, ISO 12185	≤ 1000	960
Kinematic viscosity (mm²/s)	ISO 3104		
100°C		---	6
40°C		≤ 35	34
-20°C		≤ 3000	1700
Flash-point (°C)	ISO 2719	≥ 250	>283
Fire-point (°C)	ISO 2592	≥ 300	>315
Pour-point (°C)	ISO 3016	≤ -45	< -48
CHEMICAL			
Water content (mg/kg)	IEC 60814	≤ 200[b]	≤ 50
Acidity (mg KOH/g)	IEC 62021 -1, IEC 62021 -2	≤ 0.03	0.01 – 0.02
OXIDATION STABILITY			
164 h @ 120°C	IEC 61125, Method C		
Total acidity (mg KOH/g)		≤ 0.3	0.13
Total sludge (% mass)		≤ 0.01	<0.01
800 h @ 120°C	IEC 61125, Method C		
Total acidity (mg KOH/g)		---	0.21
Total sludge (% mass)		---	<0.01
ELECTRICAL			
Break down voltage (kV)	IEC 60156	≥ 45[b]	68
	ASTM D1816		59
Dielectric dissipation factor (tanδ) 90°C and 50 Hz	IEC 60247, IEC 61620	≤ 0.03[b]	0.01
DC resistivity at 90°C (GΩ.m)	IEC 60247	≥ 2	60

[a] IEC 61099 requires testing synthetic ester liquids according to IEC 61125 method C for 164h. Envirotemp 360 was tested for 800h.
[b] for untreated liquid, as received

Material Compatibility

Envirotemp™ 360 fluid is compatible with most materials used in conventional mineral oil filled transformers. Some restrictions may exist with materials such as PVC's, certain silicone rubber formulations, and polyurethanes. It is recommended to verify the chemical compatibility for each application.

Storage Location

Indoor tank storage is preferable. Since the fluid viscosity increases at low temperatures, indoor controlled temperatures reduce the need for heating the fluid to proper pumping and filtering temperatures.

For outdoor installations, a thermal insulating backfill should be considered for economic advantages. Despite having a low pour point temperature, increased fluid viscosity at low temperatures may make it difficult to handle.

Storage Temperature

Envirotemp 360 fluid can be pumped directly from storage tanks. If suction line lengths or suction lift heights are excessive, warming of the Envirotemp 360 fluid may be desired to reduce the viscosity.
If heating of Envirotemp 360 fluid is required, the following systems are recommended:

- A circulating pump and piping with a low watt density electric heater (in line) can be attached to the storage tank to maintain temperatures of 38°C (100°F) or higher (i.e., a 76 liter/min (20 GPM) pump with a 10 kW heater will maintain a temperature of 43°C (110°F) in a 19 m^3 (5,000 gal) storage tank if heat losses to the environment are not excessive). The tank and piping should be insulated if ambient temperatures are low, to help minimize heating costs.

Tanks

Standard steel storage tanks conventionally used for transformer oil are satisfactory. Tanks should conform to local codes and standards. New tanks are preferred, should have at least one manhole, and should be protected from moisture by nitrogen blanketing. Before use, the inside of tanks should be sandblasted and primed with a coating compatible with synthetic ester fluid. Primers used for transformers' interiors are recommended. Existing storage tanks that have been used for conventional transformer oil can be used for Envirotemp 360 fluid if the following conditions are met:

- The tank is of proper capacity and the lines for filling and suction areadequate.
- The tank is thoroughly cleaned and inspected closely for any rusting condition orleakage.

Drum Handling Storage

- The Envirotemp 360 fluid-filled drums are sealed at the factory to protect against foreign material and moisture contamination during shipping. Seals over the bung plugs assure that the drum has not been opened.
- When drums of Envirotemp 360 fluid are to be stored, it is good practice to store them in a dry, temperature-controlled building. It is recommended the drum be stored horizontally with the bungs of the drum below the level of the fluid inside.
- A drip pan or basin is always recommended for drum storage.

CONTACT

Contact your sales representative for pricing and availability of the product

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Cargill

MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Material name	ENVIROTEMP FR3 FLUID
Version #	01
Issue date	06-13-2012
Revision date	-
Supersedes date	-
CAS #	Mixture
MSDS Number	12.55.1
Product use	Dielectric Coolant
Manufacturer/Supplier	Industrial Oils & Lubricants 9320 Excelsior Blvd. Hopkins, Minnesota 55343 US IOLCustomerService@cargill.com
General Information:	1-800-842-3631
Emergency	Emergency Telephone: 1-800-424-9300

2. Hazards Identification

Physical state	Liquid.
Appearance	Green Liquid.
Emergency overview	CAUTION! Prolonged or repeated skin contact may cause drying, cracking, or irritation.
OSHA regulatory status	This product is not hazardous according to OSHA 29CFR 1910.1200.
Potential health effects	
Routes of exposure	Skin contact.
Eyes	Direct contact with eyes may cause temporary irritation.
Skin	Prolonged or repeated contact may cause itching, redness, and rash in some individuals.
Inhalation	Under normal conditions of intended use, this material is not expected to be an inhalation hazard.
Ingestion	No harmful effects expected in amounts likely to be ingested by accident.

3. Composition / Information on Ingredients

Components	CAS #	Percent
Vegetable Oil	8001-22-7	> 98.5

Composition comments All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First Aid Measures

First aid procedures

Eye contact	Any material that contacts the eye should be washed out immediately with water. If easy to do, remove contact lenses. Get medical attention promptly if symptoms occur after washing.
Skin contact	Wash skin with soap and water. Get medical attention promptly if symptoms occur after washing.
Inhalation	If symptomatic, move to fresh air. Get medical attention if symptoms persist.
Ingestion	First aid is normally not required. However, if greater than 1/2 liter (pint) ingested, seek medical attention.

5. Fire Fighting Measures

Flammable properties No unusual fire or explosion hazards noted.

Extinguishing media	
Suitable extinguishing media	Water. Water fog. Foam. Dry chemical powder. Carbon dioxide (CO_2).
Fire fighting equipment/instructions	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Hazardous combustion products	Carbon oxides.

6. Accidental Release Measures

Personal precautions	Wear appropriate personal protective equipment (See Section 8).
Environmental precautions	Environmental manager must be informed of all major releases.
Methods for cleaning up	Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Large Spills: Flush area with water. Prevent runoff from entering drains, sewers, or streams. Dike for later disposal.

7. Handling and Storage

Handling	Observe good industrial hygiene practices.
Storage	Keep container closed.

8. Exposure Controls / Personal Protection

Occupational exposure limits	No exposure limits noted for ingredient(s).
Engineering controls	Ensure adequate ventilation, especially in confined areas.
Personal protective equipment	
Eye / face protection	Wear safety glasses with side shields (or goggles).
Skin protection	Wear chemical-resistant gloves, footwear and protective clothing appropriate for risk of exposure. Contact glove manufacturer for specific information.
Respiratory protection	If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Respirator type: Air-purifying respirator with an appropriate, government approved (where applicable), air-purifying filter, cartridge or canister.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical & Chemical Properties

Appearance	Green Liquid.
Physical state	Liquid.
Form	Liquid.
Color	Green.
Odor	Mild.
Odor threshold	Not available.
pH	Neutral
Vapor pressure	< 0.01 mm Hg @ 20 °C
Vapor density	Not available.
Boiling point	> 680 °F (> 360 °C)
Melting point/Freezing point	Not Available
Solubility (water)	Insoluble
Specific gravity	0.92
Flash point	590 - 608 °F (310 - 320 °C) Closed Cup
Flammability limits in air, upper, % by volume	Not Available.
Flammability limits in air, lower, % by volume	Not Available.
Auto-ignition temperature	753.8 - 759.2 °F (401 - 404 °C)

VOC	< 0.001 g/l
Viscosity	33 - 35 mm²/s @ 40 °C
Other data	
Decomposition temperature	Not Available.

10. Chemical Stability & Reactivity Information

Chemical stability	Material is stable under normal conditions.
Conditions to avoid	Excessive heat.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.
Possibility of hazardous reactions	Hazardous polymerization does not occur.

11. Toxicological Information

Sensitization	No sensitizing effects known.
Acute effects	Prolonged or repeated skin contact may cause drying, cracking, or irritation.
Local effects	High mist concentrations may cause irritation of respiratory tract.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.
Symptoms and target organs	Prolonged or repeated skin contact may cause drying, cracking, or irritation.

12. Ecological Information

Ecotoxicity	Not expected to be harmful to aquatic organisms.
Persistence and degradability	No data available.
Bioaccumulation / Accumulation	No data available.
Mobility in environmental media	No data available.

13. Disposal Considerations

Disposal instructions	Dispose of contents/container in accordance with local/regional/national/international regulations.
Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport Information

DOT

Not regulated as a hazardous material by DOT.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

TDG

Not regulated as dangerous goods.

15. Regulatory Information

US federal regulations	This product is not hazardous according to OSHA 29CFR 1910.1200. All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA (Superfund) reportable quantity (lbs) (40 CFR 302.4)

None

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - No Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No
Section 302 extremely hazardous substance (40 CFR 355, Appendix A)	No
Section 311/312 (40 CFR 370)	No
Drug Enforcement Administration (DEA) (21 CFR 1308.11-15)	Not controlled
WHMIS status	Non-controlled

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s)

State regulations This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Not listed.

US. Massachusetts RTK - Substance List

Vegetable Oil (CAS 8001-22-7) Listed.

US. New Jersey Worker and Community Right-to-Know Act

Not regulated.

US. Pennsylvania RTK - Hazardous Substances

Vegetable Oil (CAS 8001-22-7) Listed.

16. Other Information

Further information	HMIS® is a registered trade and service mark of the NPCA.
HMIS® ratings	Health: 1 Flammability: 1 Physical hazard: 0
NFPA ratings	Health: 1 Flammability: 1 Instability: 0
Disclaimer	To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

GPR

Civil Engineering • Land Planning • Land Surveying

Engineering Solutions
for Land & Structures

July 16, 2021

City of Haverhill
Office of the Fire Chief
City Hall, Room 113
4 Summer Street
Haverhill, MA 01830

Attention: Lieutenant Michael Picard & Deputy Chief Eric Tarpy

Subject: 139 Amesbury Line Road Solar Project
Fire Lane Treatments

Dear Haverhill Fire Department:

On behalf of the project proponent, Solar Smart, LLC, and the property owner, Ted & Bernadette Xenakis, and in consultation with the abutting property owners Gerry Boucher (189 Amesbury Line Road) and Bill Pepe (199 Amesbury Line Road), GPR is requesting that the City of Haverhill Fire Department review the attached materials to then accept the following proposed fire lane treatments in accordance with Haverhill Zoning Ordinance Section 7.8.7.4.

The first of the proposed driveway from Amesbury Line Road is proposed according to the Solar Driveway Exhibit Plan cross section details prepared by GPR in the attachment to this letter.

After the first 235± feet, the proposed driveway will transition back to a standard gravel driveway.

The intention of the first 235± feet is to provide a stable, compacted driving surface for heavy vehicles that is closer to the appearance of an old country cart road.

The plastic cellular confinement grid product is manufactured by various companies, and the information contained within is from one such manufacturer, Invisible Structures, for a proprietary product named GrassPave2. This product has been chosen because of the research and documentation available demonstrating its strength and durability in a variety of applications. Other products, if determined to be equivalent in strength, function and durability, may be substituted due to pricing or availability.

The technical data provided demonstrates that the cellular confinement structure is suitable for heavy vehicular loads, and is also durable throughout yearly seasonal changes, and can be maintained year-round both by mowing and snow removal.

The addition of raised compacted gravel wheel path, with grass strips in between makes this sturdy driveway look more like an old cart path. This appearance is more pleasing to the abutters and is less likely to encourage errant cars from trying to use the driveway for recreational purposes. There are no recreational facilities down this driveway, so maintaining the appearance of a lazy cart path addresses a very specific security concern not to encourage unsolicited access on the driveway.

The first 235± feet of the driveway also happens to be perfectly straight, and with a longitudinal slope of less than 1%, approximately at 0.006 FT/FT slope. If any emergency or maintenance vehicle were to swerve off of the slight raised gravel wheel paths, the underlying structure provides a stable recovery and alternate driving area capable of supporting heavy vehicles.

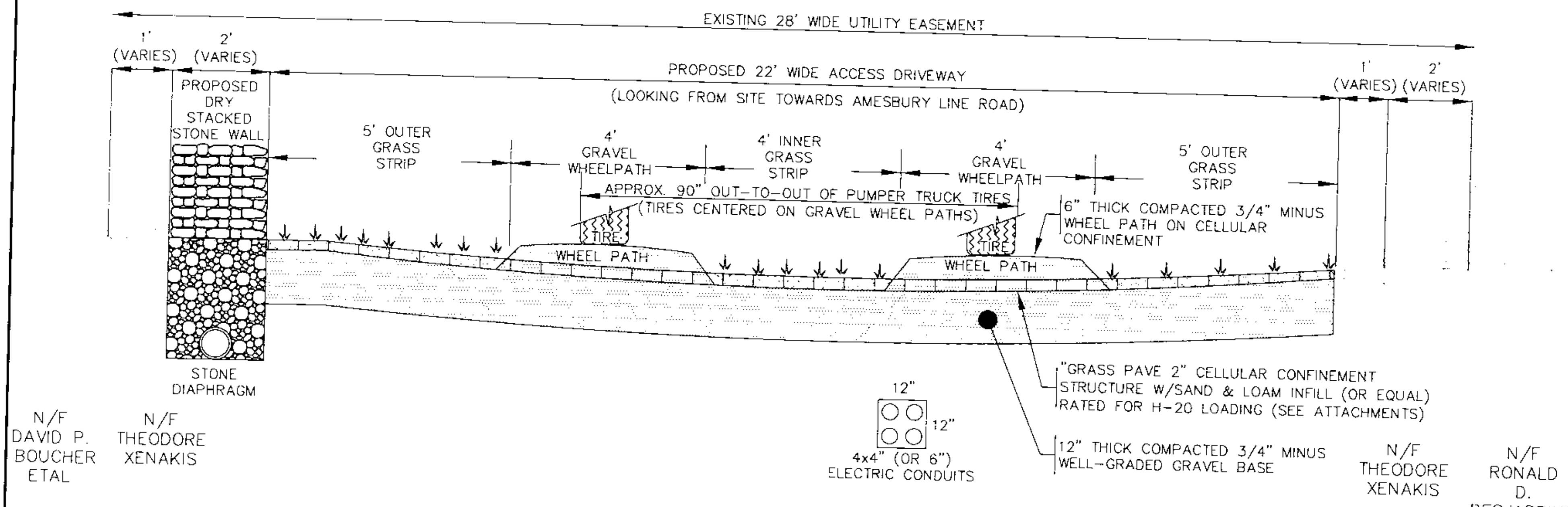
We hope that this proposal for fire lane treatment meets with the acceptance and approval of the City of Haverhill Fire Department for life safety and emergency vehicle passage in accordance with the requirements of Haverhill Zoning Ordinance Section 7.8.7.4.

If you have any questions or concerns about this proposal, please contact me at (978) 772-1590 and/or email kburchard@gpr-inc.com.

Sincerely,
Goldsmith, Prest & Ringwall, Inc.

Kyle Burchard, P.E.
Project Manager

Copy to: Owner, Client, GPR #181084 file



GRAPHIC SCALE

(IN FEET)
1 INCH = 2 FEET

GPR
Engineering Solutions
for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.
39 MAIN ST SUITE 301 AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978 772 1590 FAX: 978 772 1591
www.gpr-inc.com

PREPARED FOR:

SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

SOLAR DRIVEWAY EXHIBIT PLAN

139 AMESBURY LINE ROAD
HAVERHILL, MA 01234

DES'D BY: JFB	CHK'D BY: KFB
DATE: JUNE 11, 2021	
PROJECT: 181084	1 OF 1

P:\18---\181084\DWG\PERMIT\SOLAR SITE-REV1.DWG 06-11-21 2:16:35 PM - LAYOUT EXHIBIT 0+10

LEGEND

ABBREVIATIONS

DRAWING ISSUED FOR:

■ PERMIT

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SOLAR PHOTOVOLTAIC PROJECT

OVERALL SITE PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

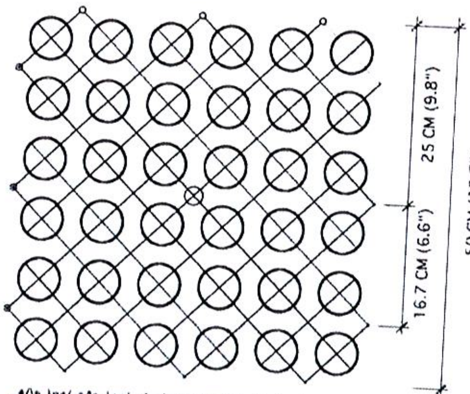
GRASSPAVE2

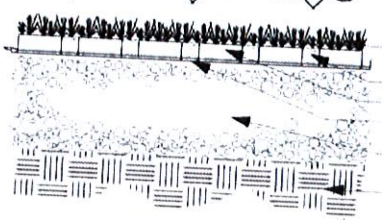
BY INVISIBLE STRUCTURES™

100% Grass Covered Porous Pavement

Grasspave2 Flexible Plastice Porous Pavement

Grasspave2 protects and enhances the environment in three ways: First, made from 100% recycled plastic, Grasspave2 keeps common consumer and industrial products from going into landfills. Second, grass paving directly improves the environment by recharging water tables on site (reducing flooding hazards downstream), reducing sources of oils and solvents from asphalt, absorbing carbon dioxide, and creating oxygen. Third, it enhances the beauty and quality of the built environment – replacing hot asphalt paved areas with cool, sparking green lawn-like
Product Description





- Maximum porosity
- Low to zero runoff
- Free air/water movement
- Permits more trees
- Cooler site
- Greater oxygen
- Removes air pollutants
- Can preserve existing trees
- Helps to meet "Green Coverage Codes"
- Fast, low cost installation
- Competes in cost with asphalt paving
- No gutter and rain system needed
- No added land required for detention facilities
- Lower life cycle costs

Applications

- Church/employee parking
- Overflow and event parking
- Golf cart paths
- Residential driveways
- Firelanes

Grasspave2 has thin-walled independent plastic rings connected by an interlocking geogrid structure, which, because it is installed below the surface, is invisible in the completed project. While the rings are rigid, the grid itself is flexible, which makes it easy to install on uneven grades, and reduces usual cut and fill requirements.

The rings transfer loads from the surface to the grid structure and engineered base course material below, thus preventing compaction of the upper root zone of the grass. A single ring supports small loads, such as shoes; several rings support tires and large loads.

The rings also act to contain the root zone medium (sand) and prevent lateral migration away from tires, feet, or other loads. This protects the grass root system, enabling roots to grow deep into the porous base course. The result is healthy, green turf at the surface.

One person can easily install the Grasspave2 rolls at a rate of 70m2 (750 ft2) per hour, plus time for base course preparation and grass installation (seeding, sod or sprigging). Step-by-step instructions are included in our Installation Instructions, which accompany each order.

Features and Benefits

- Allows 100% grass coverage instead of asphalt
- Made from 100% post consumer plastic
- High strength to weight load-bearing capacity
- Supports vehicular and pedestrian traffic

Specifications

Unit Size – 20"x 20"x 1" (50 x 50 x 2.5cm)
Unit Weight – 18oz (510 grams)
Strength – 15,940 psi (109,906 kPa)
Connector Pull Apart Strength (Tensile) - 458 lbf/in
Color – Black
Resin – 100% recycled HDPE with 3% carbon black
Shipped in Rolls (431 sq ft standard, other roll sizes available)
92% Void Space (8% plastic by volume)

Invisible Structures, Inc.
303-233-8383
www.invisiblestructures.com
US Patent #5,250,340

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Base Course Depth Recommendations
GRASSPAVE2 and GRAVELPAVE2

	Normal Traffic		Occassional Passes		Infrequent Passes	
	CBR 2-4	CBR >4	CBR 2-4	CBR >4	CBR 2-4	CBR >4
Heavy Fire Truck & H-20 Loading Max 110 psi 80000 lb	14 in	12-14 in	12-14 in	12 in	12 in	10-12 in
Light Fire Truck & H-15 Loading Typical 85 psi 60,000 lb	12 in	10-12 in	10 in	8-10 in	8-10 in	8 in
Utility & Delivery Truck & H-10 Loading Typical 60 psi 40,000 lb	8-10 in	8 in	8-10 in	6-8 in	6-8 in	6 in
Cars & Pick-Up Truck Access Typical 45 psi 8,000 lb	6-8 in	6 in	6 in	4-6 in	4-6 in	2-4 in
Trail Use and Cart Paths <1,000 lb	6 in	4-6 in	2-4 in	0-2 in	None	None

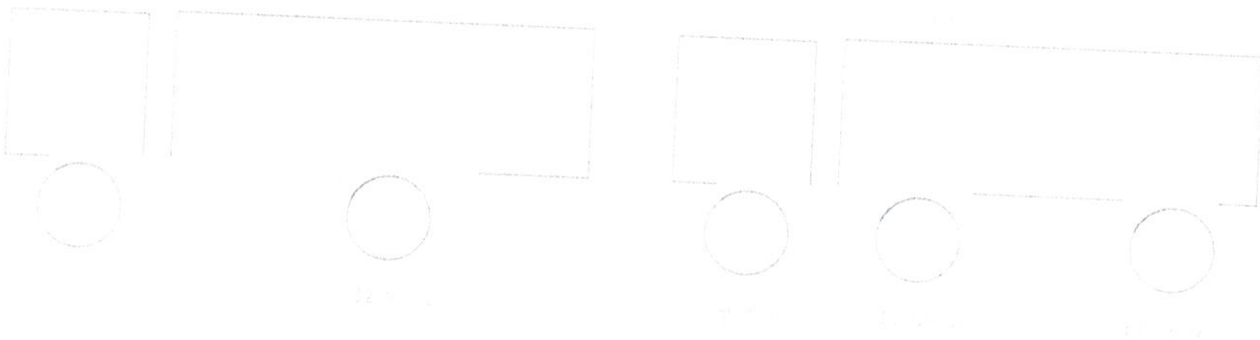
*** THESE DEPTH RECOMMENDATIONS SHOULD BE VERIFIED BY THE PROJECT ENGINEER AND LOCAL AUTHORITIES**

GRASSPAVE2 BY INVISIBLE STRUCTURES

GRAVELPAVE2 BY INVISIBLE STRUCTURES

V4.1

H-20 and HS-20 loading



Dynamic Load Sample Calculation

Wheel load = W_L= 8000 lbs (32,000 lb axle / 4)
Dynamic Force = F_d = 1.2 (20% greater than static force)
Spread Area = A = 256 si (12" cover w/45 degree angle)
Weight of base = d_y = 0.97 psi (12" road base @ 140 lbs/cf)

$\sigma va = (W_L \times F_d \;/ A) + d_y$

σva = (8000 lbs x 1.2 / 256 sqin) + 0.97 lbs

σva= 38.5 psi load results at top of RS3 Chamber

38.5 psi (256 kPa) on Rainstore3 Chamber with H-20/HS-20 Loads
[47.8 psi (330 kPa with HS-25 Loads]

Rainstore3 has been independently field and laboratory tested to meet H-20 Bridge Loading.

Lab tests determine average Rainstore3 load capacity to be 93 psi at 2x safety factor.

Grasspave2, Gravelpave2, and Slopetame2 can withstand 15,940 psi with fill material (109,906 kPa) or 2.3 mil lbs/sq ft.

Surface Pressure

32,000 lb load for single rear axle

32,000 lbs / 4 tires per rear axle = 8000 lbs per tire

100 sqin = contact area (10" x 10 ")

8000 lbs / 100 sq inches = 80 psi

80 psi (552 kPa) Static at Top of Cover

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303-233-8383

GRASSPAVE²
BY INVISIBLE STRUCTURES

Snow Removal from Grasspave²

Since 1982, most of our product sales have been to projects with secondary firelanes that cities required be kept free from depths of snow (usually 2 to 3" max) for emergency access. Over 1000 firelanes have been installed with our grass paver products - with at least half in regions subject to snowfall.

We have given all of the clients, contractors, and city agencies the same guidelines for removal of snow from our surfaces - use skids on the corners of snowplow blades.

Westfarms Mall in Farmington, Connecticut installed 6 acres of our Grasspave2 system for parking purposes, primarily used during the Christmas season. The grass looks beautiful after the first 3 years of use. They use skid rollers on dump truck mounted plows and have sustained no substantial damage due to plowing.

The idea to use skid plates was given to us by our very first client - the Snowmass Club, in Snowmass Colorado after they plowed snow 95 days during their first winter of 1982-83. Installed in October, days before snow fell, the 6,000 sf of 6 foot wide grass paved shoulders of the asphalt firelane/cart and pedestrian path had both horizontal and vertical curves in abundance.

Only 4% of the grass pavement was lost the first winter - and the plow did not have skids! They told us how to avoid damage in the future and suggest the skids to all future clients - which we have done. We never had additional requests for replacement product from the Snowmass Club again. Most of the pavement remains in place today except for areas lost to new tennis courts and pathways.

Another means to remove snow is the snowblower - most of which have a height adjustment capability to avoid direct blade contact with the surface. Tractor mounted brooms could be used with extreme care, but are not recommended as the potential for severe damage to the grass plant's crown is too high.

Please call us with any specific questions or concerns. Thank you.

GRASSPAVE2

GRAVELPAVE2

BASE COURSE MATERIAL RECOMMENDATION

Sandy Gravel material from local sources commonly used for road base construction, passing sieve analysis:

Sieve % Passing

1"	100
¾"	80 - 100
3/8"	60 - 80
#4	40 - 60
#10	25 - 40
#40	5 - 25
#200	0 - 5

Acceptable alternate base: AASHTO #57 stone mixed with clean, sharp sand (ASTM C- 33) at a rate of 70% stone to 30% sand for full depth of base.

Make sure to avoid using materials such as recycled asphalt, limestone and decomposed granite, as they will cause problems with the porosity and/or pH levels.

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Pioneering Stormwater Solutions

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303.233.8383

Cold Weather Performance of Grasspave2 and Gravelpave2

Grasspave2 and Gravelpave2 have many advantages for use in cold climates over hard surface impermeable pavements, such as asphalt and concrete.

Porous Paving is more resistant to freezing. Damp underlying soils hold heat beneath the paved surface (Backstrom 2000). Porous pavement exhibits increased speed in thawing compared to conventional pavements, due to the ability of melted water to flow directly through the pavement, increasing the temperature in the cross-section (2003, "N.E.M.O.").

Grasspave2 and Gravelpave2 are made from flexible, High Density Polyethylene (HDPE) plastic with UV inhibitors, which withstands repeated freeze-thaw cycles and continuous subzero temperatures without cracking. HDPE resists aggressive chemicals such as road salts, motor oils and fuels. HDPE is highly abrasion-resistant and is unaffected by extremes in pH (Eastpoint Oltean Co & Plastic Pipe Institute).

The expansion and contraction of the HDPE in Grasspave2 and Gravelpave2 caused by temperature variations will not affect the performance of the systems. Flexibility in the snap fitting connectors and in the connecting grid, absorb the thermal expansion/contraction due to temperature fluctuations. Since, Grasspave2 and Gravelpave2 are only 6% plastic per volume (of the top 1.25" section), with a coefficient of expansion of 0.00007 [HDPE] (Eastpoint Oltean Co.), these products will not experience any noticeable expansion.

A proper base course material, 3/4 inch minus sandy gravel (25 to 35% void space), will also absorb much of the expansion due do temperature fluctuations, relieving most upward forces. Unlike concrete and asphalt, Grasspave2 and Gravelpave2 can flex and move with the remaining vertical forces imposed by expanding base course and subsoils. The flexible ring and grid structures were engineered to conform to natural undulations and variation in the site contours. This property also applies to shifting in the subsoils and base course due to freeze-thaw cycles.

Quicker thaw times and resistance to freezing, via porous paving, result in less de-icing chemicals and less plowing compared to impermeable hard surfaces. All season maintenance is also reduced with Grasspave2 and Gravelpave2.

In cold climates, Grasspave2 and Gravelpave2 have lifespans of 60 and 25 years, respectively, whereas impermeable asphalt and concrete have projected lifespans of 8 to 15 and 18 to 25 years, respectively.

Backstrom M. 2000. "Ground Temperature in Porous Pavement during Freezing and Thawing." *Journal of Transportation Engineering – ASCE* 126(5) (September – October): 375-381.
Backstrom M, and Viklander M. 2000. "Integrated Stormwater Management in Cold Climates." *Journal of Environmental Science and Health Part AToxic/ Hazardous Substances & Environmental Engineering* 35(8): 1237-1249.
Moser, Emily 2002, "Porous Pavements A Review of Literature," published by Penn State University
"Thermal Expansion and Contraction in Plastics Piping Systems, PPI TR-21/2001" Plastic Pipe Institute.
http://www.plasticsusa.com/hdpe.html, plasticsusa.com is published by Eastpoint Oltean Co http://nemo.uconn.edu/reducing_runoff/questions.htm is published by the University of Connecticut

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How to Incorporate Grasspave2 and Gravelpave2 into Your Runoff Calculations

Performing stormwater drainage design is one of the requirements of a site designer. Recent regulations created and enforced by the EPA require new developments to limit the amount of stormwater that flows off of a newly developed site, to be equivalent to or less, than the flow rate prior to development. The site designer must determine how much water is running off the original site, and compare this to the amount of water expected to flow off the newly developed site. Each site must have a drainage plan designed and certified by a Professional Engineer before construction can move forward.

The permeable nature of Porous Pavement is an attractive feature for the site designer because the Porous Pavement reduces the amount of stormwater runoff, and thus, reduces the amount of water that must be managed on-site. Designers often ask how to take the porous pavers Grasspave2 and/or Gravelpave2 into account when determining their runoff values.

Effective Percent Imperviousness

Porous Pavement, like Grasspave2 and Gravelpave2, is designed to allow stormwater to infiltrate back into the ground as opposed to impervious surfaces with the same function. Grasspave2 and Gravelpave2 reduce the Effective Imperviousness (I_A) of the developed site, thereby reducing the runoff and pollutant load off the site. Effective Imperviousness is defined as the combined effect of the proportion of constructed impervious surfaces to the catchment, and the connectivity of these impervious surfaces to receiving water bodies. Minimizing the Effective Imperviousness of the site helps to retain the post-development hydrology as close as possible to the pre-developed hydrology.

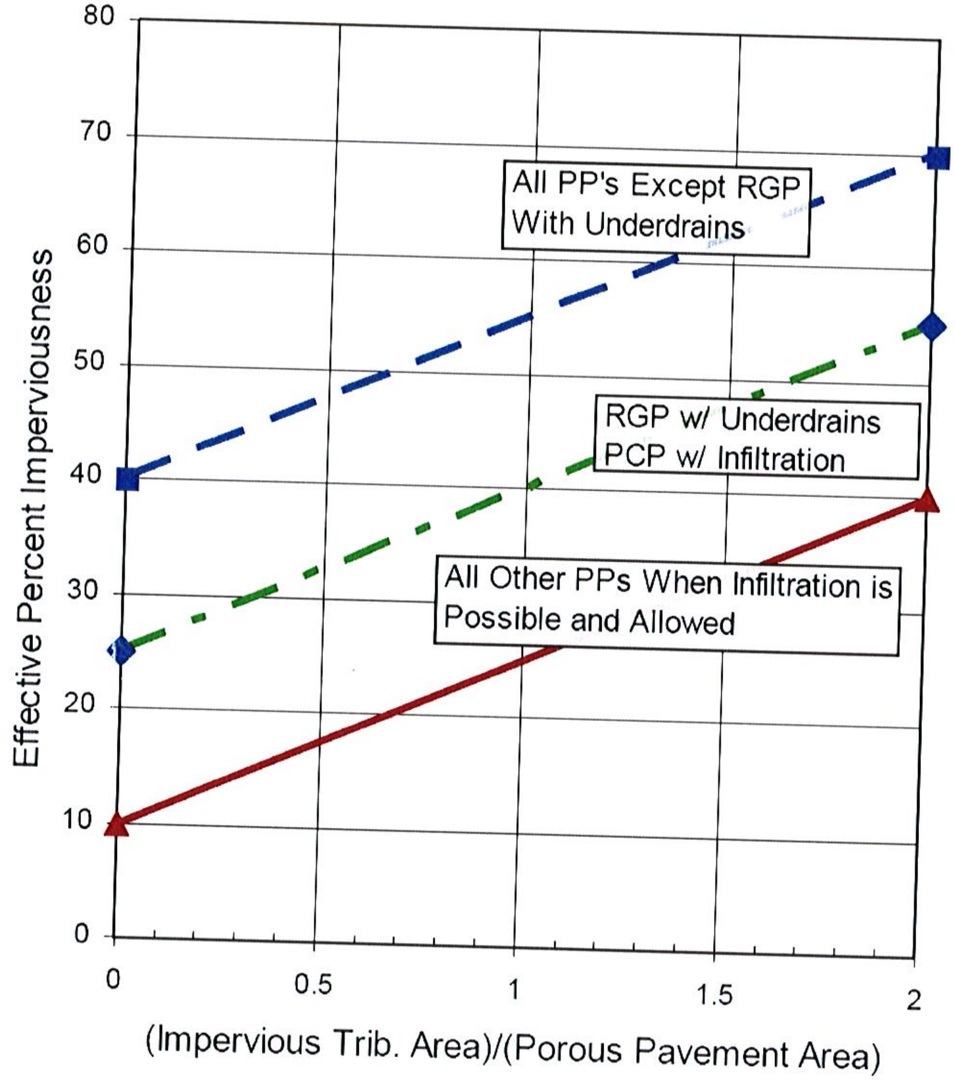
The Urban Drainage and Flood Control District has published a Drainage Criteria Manual (Vol.3) that discusses many Best Management Practices (BMPs) used industry wide to address handling stormwater on-site. Among the Structural BMPs detailed in this manual are Porous Pavements (PPs). This manual has an Effective Percent Imperviousness chart (see page 3) which details Porous Pavements and their use in different circumstances. The x-axis of this chart refers to the tributary area feeding the Porous Pavement area. The ratio of impervious tributary area to the area of Porous Pavement allows the designer to account for a site design where an impervious surface is designed to sheet flow onto a Porous Pavement. On the Chart, the bottom red line applies to all Porous Pavements, besides Porous Concrete Pavement – including Grasspave2 and Gravelpave2 – when site soils allow for infiltration. The green line refers to Grasspave2 (RGP = Reinforced Grass Pavement) used with underdrains or Porous Concrete Pavement with infiltration. The top blue line refers to all Porous Pavement types, besides Grasspave2 or Porous Concrete Pavement, when installed with underdrains. Use of underdrains would be necessary on-site if there are poor draining soils, or other drainage concerns. The on-site geotechnical engineer determines this.

Effective Imperviousness and the Rational Method
This chart provides critical information to the designer about how to incorporate the Porous Pavements Grasspave2 and Gravelpave2 into their runoff calculations. Effective Imperviousness directly correlates to the Runoff Coefficient used in the Rational Method. Both values measure the amount of expected runoff using a percentage approach. A Runoff Coefficient of 0.2 means 20% of the stormwater will runoff, while 80% will infiltrate into the ground. An Effective Imperviousness Percent of 20% translates identically. As such, the Urban Drainage chart tells that if there is no tributary area from adjacent impervious surfaces, and the site soils allow for infiltration, Gravelpave2 and Grasspave2 have an Effective Imperviousness of 10%. This equates to a Runoff Coefficient of 0.10. This value (depending on the source of the Runoff Chart) is representative of a lawn area.

Effective Imperviousness and TR-55
Effective Imperviousness also translates into the Curve Numbers used in National Resource Conservation Society's TR-55 hydrology calculation method. As demonstrated above, if there is no tributary stormwater load from adjacent impervious areas, and site soils allow water to infiltrate back into the ground, both Grasspave2 and Gravelpave2 can be considered to have a pervious nature similar to lawns, or open space in good condition. The designer can then select the appropriate Curve Number according to the site's Hydrologic Soil Group from TR-55's Table 2-2a – Open Space in Good Condition. An alternative method for determining the appropriate Curve Number would be to create a composite Curve Number. The composite Curve Number should be computed using TR-55's Figures 2-3 or 2-4 based on the Effective Impervious Area percentage (with CN = 98) given in the Urban Drainage chart and the pervious area Curve Number assuming Open Space in Good Condition.

Conclusion

The use of the Effective Percent Imperviousness Chart developed by Urban Drainage and Flood Control District allows the designer to appropriately incorporate Grasspave2 and/or Gravelpave2 into their drainage plan. Both products have been shown to have a similar runoff profiles as open spaced areas in good hydrological condition. This allows the designer to select the appropriate Runoff Coefficient or Curve Number for their hydrologic soil group, slope, and design storm. Each site has its own special needs and circumstances. As always, the designer should be aware of the assumptions and limitation of both methods, and as such, should use his or her good judgment regarding the applicability of the above values. The chart and tables included in this paper are not intended to replace reasonable and prudent engineering judgment that should permeate each step in the design process.



Notes:

1. Chart applies only to porous pavements described in Volume 3 of the USDCM, Structural MBPs chapter. Not to be used for other types of porous pavements.
2. Apply the "Effective Percent Imperviousness" to the total area that included the area of porous pavement and the tributary impervious area that can be made to flows uniformly onto PP.
3. Use no more than two units of impervious area for each unit of PP. All impervious areas exceeding this ratio shall be treated as 100% impervious in hydrologic calculations, including runoff volumes.
4. Whenever impervious areas cannot be made to run onto the pervious areas in a uniform sheet-flow fashion, identify individual areas and what ratios apply to each and then composite them reating each as a separate area.

Figure PP-1—Interim Recommended Effective Percent Imperviousness for Porous Pavements
(Based on the Ratio of the Impervious Area Tributary to Porous Pavement)

References:

Rational Method:

Runoff Coefficients for Rational Formula:
United States Department of Transportation
Federal Highway Administration
"Urban Drainage Design Manual – HEC 22" – November 1996
"Table 3-1. Runoff Coefficients for Rational Formula"
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec/hec22.pdf

Runoff Coefficients for the Rational Formula versus Hydrologic Soil Group (A, B, C, D) and Slope Range:
McCuen, R. Hydrologic Analysis and Design – 3rd Edition
http://www.bossintl.com/download/RunoffCoefficients.html

TR-55:

Table 2-2a from TR-55, Runoff Curve Numbers for Urban Areas
United States Department of Agriculture
Natural Resources Conservation Service
Conservation Engineering Division
"Urban Hydrology for Small Watersheds: Technical Release 55" – June 1996
http://www.cpesc.org/reference/tr55.pdf

Effective Imperviousness Chart:

Urban Drainage and Flood Control District
"Urban Storm Drainage Criteria Manual Volume III" – 2008 latest revision
Section 04 – Structural BMP
http://www.udfcd.org/downloads/down_critmanual_volIII.htm

INVISIBLE STRUCTURES
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April 2015

Grasspave2 Product Specification (CSI Format)

Notes: This product guide specification is written according to the Construction Specifications Institute (CSI) Format, including *MasterFormat* (1995 Edition), *SectionFormat*, and *PageFormat*, contained in the CSI *Manual of Practice*.

The section must be carefully reviewed and edited by the Engineer to meet the requirements of the project and local building code. Coordinate with other specification sections and the drawings.

Delete all "Specifier Notes" when editing this section.

SECTION 32 12 43
POROUS FLEXIBLE PAVING
(Formerly 02795 Porous Paving)

Notes: This section covers Grasspave2 Porous Pavement System from Invisible Structures. The system provides vehicular and heavy load support over grass areas while protecting grass roots from harmful effects of traffic.

The major components of the complete system are the Grasspave2 units, an engineered base course, Hydrogrow soil amendment/fertilizer, sand, and grass from seed, hydromulch, or sod.

Consult Invisible Structures, Inc. for assistance in editing this section for the specific application.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Porous pavement system.

1.2 RELATED SECTIONS

A. Section [31 20 00 – Earth Moving] [__ __ __ - ___________].
B. Section [33 46 00 – Subdrainage] [__ __ __ - ___________].
C. Section [32 10 00 – Bases, Ballasts, and Paving] [__ __ __ - ___________].

Notes: Edit the following list as required for the project. List other sections with work directly related to the porous pavement system.

D. Section [32 30 00 - Site Improvements] [__ __ __ - ___________].
E. Section [32 90 00 Planting] [__ __ __ - ___________].
F. Section [32 92 00 – Manufacturers of Turfs and Grasses] [__ __ __ - ___________].
G. Section [32 80 00 – Irrigation or Section 32 84 13 – Drip Irrigation] [__ __ __ - ___________].

1.3 REFERENCES

A. ASTM F 1951-08 Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.

B. ASTM D 638-10 Standard Test Method for Tensile Properties of Plastics

C. ASTM C 33 Standard Specification for Concrete Aggregates

D. AASHTO M6 Standard Specification for Fine Aggregate for Hydraulic Cement Concrete

1.4 SYSTEM DESCRIPTION

A. The Grasspave2 porous pavement system provides vehicular and pedestrian load support for grass areas, while protecting grass roots from harmful effects of traffic.

B. Major Components of the Complete System

1. Grasspave2 units, assembled in rolls.
2. Engineered sand and gravel base course.
3. Hydrogrow soil amendment and fertilizer, supplied with Grasspave2.
4. Sand fill or USGA greens mix.
5. Selected grass from seed, hydroseeding/hydro-mulching, or sod.
6. Selected topsoil (only for seeded installation).
7. Mulch (needed only for seeded or hydroseeded installations).

C. The Grasspave2 grass paving units, sand, and base course work together to support imposed loading.

D. The Grasspave2 grass paving units, Hydrogrow, and sand fill contribute to vegetation support.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Shop Drawings: Submit design detail showing proper cross-section.

C. Samples: Submit manufacturer's sample of Grasspave2 10" x 10" section of Grasspave2 material.

D. Installation Instructions: Manufacturer's printed installation instructions. Include methods for maintaining installed products.

E. Certificates:

1. Manufacturer signed certificate stating the product is made in the USA.
2. Submit Material Certificates for base course and sand (or USGA mix) fill materials
3. Product certificates signed by the manufacturer certifying material compliance of polyethylene used to make Grasspave2 units.
4. ISO Certificate certifying manufacturer's quality management system is currently registered to ISO 9001:2008 quality standards.

F. LEED Submittals: Provide documentation of how the requirements of Credit will be met:

1. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product having recycled content.
2. Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content.
3. Description of Grasspave2 in stormwater design to limit the disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.
4. Designing elements for Grasspave2 to limit the disruption and pollution of natural water flows by managing stormwater runoff.
5. Documenting the use of Grasspave2 to reduce heat islands to minimize the impact on

microclimates and human and wildlife habitats.

G. Substitutions: No material will be considered as an equivalent to the Grasspave2 unit specified herein unless it meets all areas of this specification without exception. Manufacturers seeking to supply what they represent as equivalent material must submit records, data, independent test results, samples, certifications, and documentation deemed necessary by the Specifier to prove equivalency.

H. Manufacturer's Material Certification: Product manufacturers shall provide certification of compliance with all applicable testing procedures and related specifications upon written request. Request for certification shall be submitted by the purchasing agency no later than the date of order placement.

I. Product manufacturers shall also have a minimum of 30 years' experience producing products for porous pavement systems.

J. Manufacturer Quality Certification: ISO Certification certifying manufacturer's quality management system for its Grasspave2 system is currently registered to ISO 9001:2008 quality standards. Any alternate materials submitted shall provide a certification that their porous pavement system manufacturing process is part of an ISO program and a certification will be required specifically stating that their testing facility is certified and in accordance with ISO.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect Grasspave2 units/rolls from damage during delivery and store rolls upright, under tarp, to protect from sunlight, when time for delivery to installation exceeds one week.

C. Store Hydrogrow in a dark and dry location

D. Handling: Protect materials during handling and installation to prevent damage

1.7 MAINTENANCE SERVICE

Notes: Once healthy turf has been established, the cell wall structure will have minimal visibility when proper turf maintenance practices are followed.

A. Installer responsible for maintenance of grass plants – water/irrigation, fertilizing, mowing – for one growing season. DO NOT AERATE. See *Grasspave2 Maintenance Guide* from Invisible Structures

B. System to be maintained by ________________________, after one growing season.

1.8 Project Conditions

A. Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not begin installation of porous pavements until all hard surface paving adjacent to porous pavement areas, including concrete walks and asphalt paving, is completed.

C. Install turf when ambient air temperatures is at least 55 degrees F (13 degrees C).

D. In cold weather, do not use frozen materials or materials mixed or coated with ice or frost, and do not build on frozen base or wet, saturated or muddy subgrade.

E. Protect partially completed paving against damage from other construction traffic when work is in progress.

F. Adequately water sod or grass seed to assure germination of seed and growth of root system.

G. Grass coverage on the sand-filled Grasspave2 rings must be completed within one week: See *Part 3 Execution*.

H. DO NOT DRIVE, PARK ON, or use Grasspave2 system for two or three mowing cycles until grass root system has matured (about 3 to 4 weeks for sod or 6 to 8 weeks for seeded areas). Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.

1.9 LIMITED WARRANTY

A. Invisible Structures, Inc. (ISI) warrants to its purchasers that all products furnished by ISI will be free from defects in material and/or workmanship.

B. This warranty shall be extended for a period of five (5) years following the date of shipment by ISI.

C. Providing a written claim is presented to ISI within the warranty period and after inspection by ISI showing the materials have failed under this warranty, all defective materials shall be refurnished under this warranty, at no charge, excluding re-installation costs. This in lieu of all other warranties expressed or implied and is the sole warranty extended by ISI.

D. Our liability under this warranty is limited to the refurnishing of materials and does not include any responsibility for incidental, consequential, or other damages of any nature.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Invisible Structures, Inc., which is located at: 3510 Himalaya Rd. Suite 200 ; Aurora, CO 80011; Tel: 303-233-8383; Web: www.invisiblestructures.com.

B. Substitutions: Not permitted.

2.2 GRASSPAVE2

A. Composition:
   1. Manufactured in the USA.
   2. High density polyethylene (HDPE): 100 percent recycled materials.
   3. Color: black
   4. Color Uniformity: Uniform color throughout all units rolls.
   5. Carbon Black for ultraviolet light stabilization.
   6. Hydrogrow soil amendment and fertilizer, provided by manufacturer with Grasspave2.

B. Performance Properties:
   1. Maximum Loading Capability: 15,940 psi (2.29 million psf, 109,906 kPa) when filled with sand.
   2. Wheelchair Access testing for ADA Compliance: Passing ASTM F 1951-08.
   3. Wheelchair Access testing for ADA Compliance: Passing Rotational Penetrometer testing.
   4. Tensile strength, pull-apart testing: 458 lbf/in from ASTM D638 Modified.
   5. System Permeability (Grasspave2, sand, base course): 2.63 to 38.55 inches of water per hour.
   6. Effective Imperviousness (E.I.): 10%.

C. Dimensions (individual units are assembled and distributed into rolls):
   1. Roll area: From 108 sq ft (10 sq m) to 538 sq ft (50 sq m), in 108 sq ft (10 sq m) increments
   2. Roll Widths: From 3.3 ft (1 m) to 8.2 ft (2.5 m), in 1.6 ft (0.5 m) increments.
   3. Roll Lengths: From 32.8 ft (10m) to 65.6 ft (20 m), in 3.3 ft (1 m) increments.
   4. Roll Weights: From 41 lbs (19kg) to 205 lbs (93kg), in 41 lbs (19 kg) increments.
   5. Unit Nominal Width by Length: 20 inches by 20 inches (0.5 m by 0.5 m) or 40 inches by 40 inches (1 m by 1 m).
   6. Nominal Depth: 1 inch (2.5 cm) – for rolls and individual units.
   7. Unit Weight: 18 oz (510 g) or 5 lbs. (2.27 kg).
   8. Volume Solid: 8 percent.

2.3 SYSTEM MATERIALS

Notes: All measurements are subject to manufacturing tolerances, unless otherwise specified.

A. Base Course: Sandy gravel material from local sources commonly used for road base construction (recycled materials such as crushed concrete or crushed asphalt are NOT acceptable).
   1. Conforming to the following sieve analysis and requirements:
      a. 100 percent passing sieve size 1 inch (25 mm).
      b. 80-100 percent passing sieve size 3/4 inch (19 mm).
      c. 60-80 percent passing sieve size 3/8 inch (9 mm).
      d. 40-60 percent passing sieve size #4.
      e. 25-40 percent passing sieve size #10.
      f. 5-25 percent passing sieve size #40.
      g. 0-5 percent passing sieve size #200.
   2. Provide a base course material nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.
   3. Material may be either "pit run" or "crusher run." Avoid using clay based crusher run/pit run. Crusher run material will generally require coarse, well-draining sand conforming to AASHTO M6 or ASTM C 33 to be added to mixture (20 to 30 percent by volume) to ensure long-term porosity.
   4. Alternative materials such as crushed shell, limerock, or crushed lava may be used for base course use, provided they are mixed with sharp sand (20 to 30 percent) to ensure long-term porosity, and are brought to proper compaction. Without added sand, crushed shell and limerock set up like concrete and become impervious.
   5. Alternative size and/or composition of base course materials should be submitted to Invisible Structures, Inc. (Manufacturer) for approval.

B. Sand Fill for Rings and Spaces Between Rings: Clean sharp sand (washed concrete sand). Choose one of the following:
   1. Coarse, well-draining sand, such as washed concrete sand conforming to AASHTO M6 or ASTM C-33.
   2. United States Golf Association (USGA) greens, section - sand mix "The Root Zone Mixture."

C. Turf Conditioner:
   1. Hydrogrow a proprietary soil amendment manufactured by Invisible Structures, Inc. and provided with Grasspave2.
   2. NO SUBSTITUTIONS.

Notes: Use grass species resistant to wear by traffic generally a Blue/Rye/Fescue mix used for athletic fields in northern climates, and Zoysia, Fescue, or Bermuda types in southern climates. Check with local sod and seed suppliers for preferred mixtures. Dedicated fire lanes can use same grass species used on surrounding turf. Parking applications require greatest wear-resistant species possible, generally available only by seed or hydroseeding/hydro-mulching.

D. Grass – Choose either sod or seed:

   1. Sod: [____________________]. Use 13 mm (0.5") thick (soil thickness) rolled sod from a reputable local grower. Species should be wear resistant, free from disease, and in excellent condition. Sod shall be grown in sand or sandy loam soils only. Sod grown in soils of clay, silt, or high organic materials such as peat, will not be accepted.
   2. Seed: [____________________]. Use seed materials, of the preferred species for local environmental and projected traffic conditions, from certified sources. Seed shall be provided in containers clearly labeled to show seed name, lot number, net weight, % weed seed content, and guaranteed % of purity and germination. Pure Live Seed types and amount shall be as shown on plans.
      a. Mulch – needed only for hydroseeding: Wood or paper cellulose commercial mulch materials compatible with hydroseeding operations. Mulch depth according to mulch

manufacturers' recommendation. DO NOT use mulch of straw, pine needles, etc., because of their low moisture holding capacity.

b. Topsoil – needed only for seeding, recommended for hydroseeding: Obtain specified topsoil for a light "dusting" (no more than ½" or 13mm) above rings filled with sand for seeding germination.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine subgrade and base course installed conditions. Do not start porous paving installation until unsatisfactory conditions are corrected. Check for improperly compacted trenches, debris, and improper gradients.

B. For fire lane installations: prior to installing base course for turf paving, obtain approval of local fire authorities of sub-base.

C. Start of installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Architect for resolution.

3.2 PREPARATION

Notes: Ensure that subbase materials are structurally adequate to receive designed base course, wearing course, and designed loads. Generally, excavation into undisturbed normal strength soils will require no additional modification. Fill soils and otherwise structurally weak soils may require modifications, such as geotextiles, geogrids, and/or compaction (not to exceed 90%). Ensure that grading and soil porosity of the subbase will provide adequate subsurface drainage

A. Subgrade Preparation:

1. Prepare subgrade as specified in Section 32 10 00. Verify subgrade in accordance with porous paving system manufacturer's instructions.
2. Proper subgrade preparation will enable the Grasspave2 rolls/units to connect properly and remain level and stationary after installation.

Notes: For Fire lanes and emergency access, It is recommended that Fire Department inspectors be scheduled to inspect installation of Grasspave2 during preparation of the subbase, installation of the base course, and installation of Grasspave2 units. Most small projects can accommodate these inspections all on the same day. Verify with Fire Department if certificates of inspection are required.

3. Excavate area allowing for unit thickness, the engineered base depth (where required), and 0.5 inch (1.25 cm) for depth of sod root zone or topsoil germination area (when applicable).
4. Provide adequate drainage from excavated area if area has potential to collect water, when working with in-place soils that have poor permeability.
5. Ensure in-place soil is relatively dry and free from standing water.
6. Uniformly grade base.
7. Level and clear base of large objects, such as rocks and pieces of wood.

B. Base Preparation:

1. Install Base as specified in Section 32 10 00. Verify engineered base (if required) is installed in accordance with porous paving system manufacturer's instructions.
2. Coordinate base installation and preparation with subdrains specified in Section 33 46 00.
3. If required, place a geotextile separation layer between the natural ground and the 'engineered base'.
4. If required, install the specified sub-drain and outlet according to construction drawings.
5. Coordinate base installation and preparation with irrigation and drip irrigation lines specified in Section 32 80 00 and 32 84 13, respectively.
6. Place engineered base in lifts not to exceed 6 inches (150 mm), compacting each lift separately to

95 percent Modified Proctor.

7. Leave 1 inch (2.5 cm) of depth below final grade for porous paver unit and sand fill and 0.5 inch (1.25 cm) for depth of sod root zone or topsoil germination area (when applicable).

Notes: Delete requirement for on-site manufacturer's field representative if not required

3.3 ON-SITE MANUFACTURER'S FIELD REPRESENTATIVE

A. A qualified Manufacturer's field representative shall be available for a pre-construction meeting via phone or in person and will provide installation videos, design details, installation instructions, and the technical specifications.

B. The time for on-site observation shall be indicated in the Contract Documents and included in the base bid price.

3.4 HYDROGROW INSTALLATION

A. Spread all Hydrogrow mix provided (spreader rate = 4.53 kg per 100 m2 (10 lbs per 1076 ft2) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader.

B. The Hydrogrow mix should be placed immediately before installing the Grasspave2.

3.5 GRASSPAVE2 INSTALLATION

A. Install the Grasspave2 units by placing units with rings facing up, and using snap-fit connectors, pegs and holes, provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves, slopes, and high traffic areas shall be anchored to the base course, using 40d common nails with fender washer, as required to secure units in place. Tops of rings shall be between 6 mm to 13 mm (0.25" to 0.5") below the surface of adjacent hard-surface pavements.

B. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 6 mm (0.25") above top of rings.

3.6 INSTALLATION OF GRASS

A. Grass coverage on the sand-filled rings must be completed within one week. Sand must be re-installed and leveled and Grasspave2 checked for integrity if rings become exposed due to wind, rain, traffic, or other factors. (Choose one paragraph below to meet grass installation method desired.)

Notes: Choose one paragraph below to match grass installation method

1. Preferred method: Hydroseeding/hydro-mulching - A combination of water, seed and fertilizer are homogeneously mixed in a purpose-built, truck-mounted tank. The seed mixture is sprayed onto the site at rates shown on plans and per hydroseeding manufacturer's recommendations. Coverage must be uniform and complete. Following germination of the seed, areas lacking germination larger than 20 cm x 20 cm (8" x 8") must be reseeded immediately. Seeded areas must be fertilized and kept moist during development of the turf plants.). DO NOT DRIVE ON SYSTEM: Hydroseeded/hydro-mulch areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

2. Install thin sod directly over sand filled rings, filled no higher than the top of the rings. Sod strips should be placed with very tight joints. Sodded areas must be fertilized and kept moist during root

establishment (minimum of 3 weeks). DO NOT DRIVE ON SYSTEM: Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

3. Install grass seed at rates per grass type. A light "dusting" of commercial topsoil mix, not to exceed 1/2" (25 mm) will be placed above the rings and seed mix to aid germination rates. Seeded areas must be fertilized and kept moist during development of the turf plants.). DO NOT DRIVE ON SYSTEM: Seeded areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

B. Adequately water sod or grass seed to assure germination of seed and growth of root system.

3.7 PROTECTION

Notes: Choose one paragraph below to match grass installation method.

A. Seeded areas must be protected from any traffic, other than emergency vehicles, for a period of 4 to 8 weeks, or until the grass is mature to handle traffic.

B. Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated below the Grasspave2 units.

3.8 FIELD QUALITY CONTROL

A. Remove and replace segments of Grasspave2 units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

3.9 MAINTENANCE

A. Maintain grass in accordance with manufacturer's instructions and as specified in Section 32 92 00 Manufacturers of Turfs and Grasses.

B. Lawn Care: Normal turf care procedures should be followed, including de-thatching.

C. DO NOT AERATE. Aerator will damage the Grasspave2 units. Aeration in not necessary in a sand root zone.

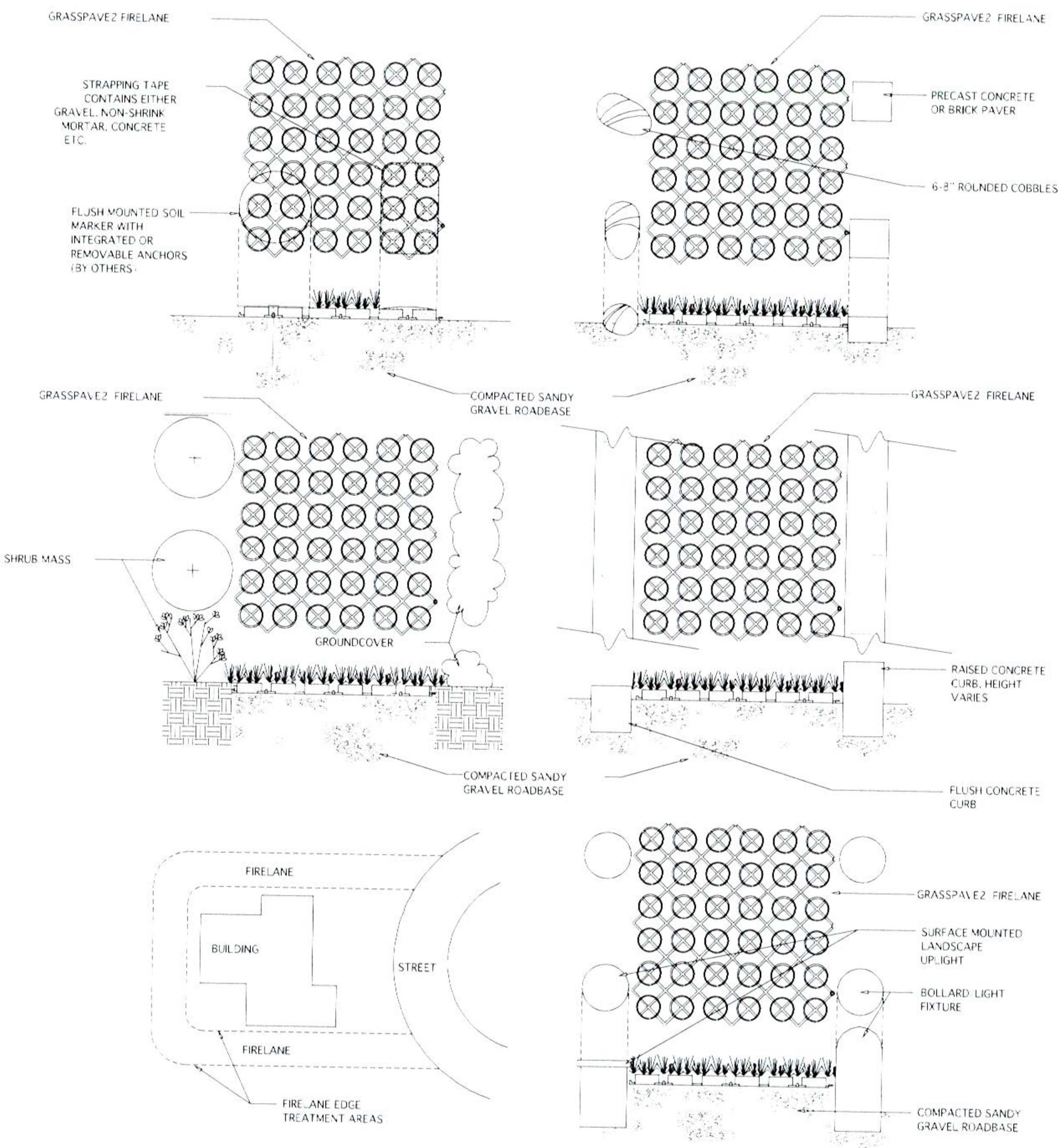
D. When snow removal is required, keep a metal edged plow blade a minimum of ¾ inch (17 mm) above the surface during plowing operations to avoid causing damage to the Grasspave2 units, or

1. Use a plow blade with a flexible rubber edge, or
2. Use a plow blade with skids on the lower outside corners set so the plow blade does not come in contact with the units.

END OF SECTION

GRASSPAVE2 Firelane Detail

Use this detail for delineating a Grasspave2 firelane



NOTE:
THIS DETAIL IS SCHEMATIC IN NATURE. DESIGNER SHALL SPECIFY SPACING AND DESIGN OF EDGE TREATMENTS. SPACING WILL VARY WITH TURF TYPE, SLOPE, FIRE DEPARTMRNT REQUIREMENTS, ETC..

NOT TO SCALE

1

1OF1

GRASSPAVE2

Invisible Structures, Inc.
GP2Firelane11.dwg

INVISIBLE STRUCTURES

303-233-8383
www.invisiblestructures.com
V4.1

GRASSPAVE2
BY INVISIBLE STRUCTURES™

INSTALLATION GUIDE - Grasspave2 Porous Grass Pavement

Introduction

A. This document describes step-by-step information on how to properly install the Grasspave2 Porous Pavement System. Grasspave2 provides vehicular and pedestrian load support for grass areas, while protecting grass roots from harmful effects of traffic. The major components of the complete system are the Grasspave2 units, an engineered base course, Hydrogrow soil amendment/fertilizer, sand, and grass from seed, hydromulch, or sod.

B. **Contractors**: Only licensed contractors should install the Grasspave2 system. The contractor should have a good performance record with similar construction projects. *Homeowners should only attempt installation after they have read and understood fully this installation guide and/or our Technical Specifications.*

C. **Landscaping:** Plant a grass species in Grasspave2 that 1) is climate appropriate, 2) will receive the necessary maintenance for the species (irrigation and fertilizer support), 3) is wear resistant to hold up to vehicular traffic, 4) can be grown in a sand-based root zone, 5) is shade tolerant (if applicable).

F. **Warning:** Unless there is an emergency, DO NOT DRIVE, PARK ON, or use Grasspave2 system for two or three mowing cycles until grass root system has matured (about 3 to 4 weeks for sod or 6 to 8 weeks for seeded areas). Any barricades constructed to prevent traffic flow must still be accessible by emergency and fire equipment during and after installation.

G. **Warranty:** Invisible Structures, Inc. (ISI) warrants to its purchasers that all products furnished by ISI will be free from defects in material and/or workmanship. This warranty shall be extended for a period of five (5) years following the date of shipment by ISI. Providing a written claim is presented to ISI within the warranty period and after inspection by ISI showing the materials have failed under this warranty, all defective materials shall be refurnished under this warranty, at no charge, excluding re-installation costs. This in lieu of all other warranties expressed or implied and is the sole warranty extended by ISI. Our liability under this warranty is limited to the refurnishing of materials and does not include any responsibility for incidental, consequential, or other damages of any nature.

Delivery, Storage, and Handling

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect Grasspave2 units/rolls from damage during delivery and store rolls upright (like a soda can), and under a tarp to protect from sunlight when time for delivery to installation exceeds one week. Do not store rolls on their sides.

C. Store Hydrogrow in a dark and dry location.

D. Handling: Protect materials during handling and installation to prevent damage.

Installation Considerations

A. Review installation procedures and coordinate Grasspave2 work with other work affected. Generally, Grasspave2 is installed at the same time as project grass installation, nearly the last site construction activity.

B. Do not begin installation of porous pavements until all hard surface paving adjacent to porous pavement areas, including concrete walks and asphalt paving, is completed.

C. Install turf when ambient air temperatures is at least 55 degrees F (13 degrees C).

D. In cold weather, do not use frozen materials or materials mixed or coated with ice or frost, and do not build on frozen base or wet, saturated or muddy subgrade.

E. Protect partially completed paving against damage from other construction traffic when work is in progress.

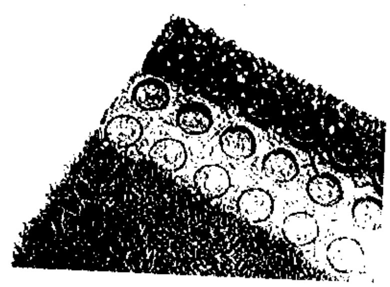
F. Adequately water sod or grass seed to assure germination of seed and growth of root system.

G. Grass coverage on the sand-filled Grasspave2 rings must be completed within one week.

H. DO NOT DRIVE, PARK ON, or use Grasspave2 system for two or three mowing cycles until grass root system has matured (about 3 to 4 weeks for sod or 6 to 8 weeks for seeded areas). Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.

Materials

A. Grasspave2 Porous Paving Rolls



B. Base Course: Sandy gravel material from local sources commonly used for road base construction **(recycled materials such as crushed concrete or crushed aggregate are NOT acceptable).**

1. Conforming to the following sieve analysis and requirements:
   100 percent passing sieve size 1 inch (25 mm).
   80-100 percent passing sieve size 3/4 inch (19 mm).
   60-80 percent passing sieve size 3/8 inch (9 mm).
   40-60 percent passing sieve size #4.
   25-40 percent passing sieve size #10.
   5-25 percent passing sieve size #40.
   0-5 percent passing sieve size #200.
2. Provide a base course material nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.
3. Material may be either "pit run" or "crusher run." Avoid using clay based crusher run/pit run. Crusher run material will generally require coarse, well-draining sand conforming to AASHTO M6 or ASTM C 33 to be added to mixture (20 to 30 percent by volume) to ensure long-term porosity.
4. Alternative materials such as crushed shell, limerock, or crushed lava may be used for base course use, provided they are mixed with sharp sand (20 to 30 percent by volume) to ensure long-term porosity, and are brought to proper compaction. Without added sand, crushed shell and limerock set up like concrete and become impervious.
5. Alternative size and/or composition of base course materials should be submitted to Invisible Structures, Inc. (Manufacturer) for approval.

C. Sand Fill for Rings and Spaces Between Rings: Clean sharp sand (washed concrete sand). Choose **one** of the following:
   1. Coarse, well-draining sand, such as washed concrete sand conforming to AASHTO M6 or ASTM C-33.
   2. United States Golf Association (USGA) greens, section - sand mix "The Root Zone Mixture."

D. Turf Conditioner:
   1. Hydrogrow a proprietary soil amendment manufactured by Invisible Structures, Inc. and provided with Grasspave2.
   2. NO SUBSTITUTIONS.

E. Grass – Choose either sod **or** seed. Use grass species resistant to wear by traffic generally a Blue/Rye/Fescue mix used for athletic fields in northern climates, and Zoysia, Fescue, or Bermuda types in southern climates. Check with local sod and seed suppliers for preferred mixtures. Dedicated fire lanes can use same grass species used on surrounding turf. Parking applications require greatest wear-resistant species possible, generally available only by seed or hydroseeding/hydro-mulching.

   1. Sod: Use 13 mm (0.5") thick (soil thickness) rolled sod from a reputable local grower. Species should be wear resistant, free from disease, and in excellent condition. Sod shall be grown in sand or sandy loam soils only. Sod grown in soils of clay, silt, or high organic materials such as peat, will not be accepted.

   2. Seed: Use seed materials, of the preferred species for local environmental and projected traffic conditions, from certified sources. Seed shall be provided in containers clearly labeled to show seed name, lot number, net weight, % weed seed content, and guaranteed % of purity and germination. Pure Live Seed types and amount shall be as shown on plans.
      a. Mulch – needed only for hydroseeding: Wood or paper cellulose commercial mulch materials compatible with hydroseeding operations. Mulch depth according to mulch manufacturers' recommendation. DO NOT use mulch of straw, pine needles, etc., because of their low moisture holding capacity.
      b. Topsoil – needed only for seeding, recommended for hydroseeding: Obtain specified topsoil for a light "dusting" (NO MORE than ½" or 13mm) above rings filled with sand for seeding germination.

F. Fertilizer: A commercial "starter" fertilizer, with Guaranteed Analysis of 17-23-6, or as recommended by local grass supplier, for rapid germination and root development.

G. Grasspave2 Sign: A sign to identify the presence of Grasspave2 paving, stating that special maintenance is required, with the Manufacturer's phone number, and made of durable materials for outdoor exposure shall be provided and installed.

H. Fire lane Signage & Delineation: Fire lanes must be identified regarding their entrance and physical location with the placement of signs, gates, curbs, bollards, etc. Specific signage wording and other details must be coordinated with and approved by local fire authorities.

INSTALLATION

Inspection

(For Fire lanes and emergency access, It is recommended that Fire Department inspectors be scheduled to inspect installation of Grasspave2 during preparation of the subbase, installation of the base course, and installation of Grasspave2 units. Most small projects can accommodate these inspections all on the same day. Verify with Fire Department if certificates of inspection are required.)

A. Examine subgrade and base course installed conditions. Do not start porous paving installation until unsatisfactory conditions are corrected. Check for improperly compacted trenches, debris, and improper gradients.

B. For fire lane installations: prior to installing base course for turf paving, obtain approval of local fire authorities of sub-base.

C. Start of installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Architect for resolution.

Preparation

(Ensure that subbase materials are structurally adequate to receive designed base course, wearing course, and designed loads. Generally, excavation into undisturbed normal strength soils will require no additional modification. Fill soils and otherwise structurally weak soils may require modifications, such as geotextiles, geogrids, and/or compaction (not to exceed 90%). Ensure that grading and soil porosity of the subbase will provide adequate subsurface drainage)

A. Subgrade Preparation:
1. Prepare subgrade as specified for project.
2. Proper subgrade preparation will enable the Grasspave2 rolls/units to connect properly and remain level and stationary after installation.
3. Excavate area allowing for unit thickness (1 in), the engineered base depth (where required), and 0.5 inch (1.25 cm) for depth of sod root zone or topsoil germination area (when applicable).
4. Provide adequate drainage from excavated area if area has potential to collect water, when working with in-place soils that have poor permeability.
5. Ensure in-place soil is relatively dry and free from standing water.
6. Uniformly grade base.
7. Level and clear base of large objects, such as rocks and pieces of wood.

B. Base Preparation:
1. Install Base as specified.
2. Coordinate base installation and preparation with subdrains (if necessary).
3. If required, place a geotextile separation layer between the natural ground and the 'engineered base'.
4. If required, install the specified sub-drain and outlet according to construction drawings.
5. Coordinate base installation and preparation with irrigation and drip irrigation lines.
6. Place engineered base in lifts not to exceed 6 inches (150 mm), compacting each lift separately to 95 percent Modified Proctor.
7. Leave 1 inch (2.5 cm) of depth below final grade for porous paver unit and sand fill and 0.5 inch (1.25 cm) for depth of sod root zone or topsoil germination area (when applicable).

Hydrogrow Installation

A. Spread all Hydrogrow mix provided (spreader rate = 4.53 kg per 100 m2 (10 lbs per 1076 ft2) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader.

B. The Hydrogrow mix should be placed **immediately** before installing the Grasspave2.

Grasspave2 Unit Installation

A. Install the Grasspave2 units by placing units with rings facing up, and using snap-fit connectors, pegs and holes, provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves, slopes, and high traffic areas shall be anchored to the base course, using 40d common nails with fender washer, as required to secure units in place. Tops of rings shall be between 6 mm to 13 mm (0.25" to 0.5") below the surface of adjacent hard-surface pavements.

B. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 6 mm (0.25") above top of rings.

Installation of Grass

A. Grass coverage on the sand-filled rings **must be completed within one week**. Sand must be re-installed and leveled and Grasspave2 checked for integrity if rings become exposed due to wind, rain, traffic, or other factors.

Notes: Choose **one** paragraph below to match grass installation method

1. Preferred method: Hydroseeding/hydro-mulching - A combination of water, seed and fertilizer are homogeneously mixed in a purpose-built, truck-mounted tank. The seed mixture is sprayed onto the site at rates shown on plans and per hydroseeding manufacturer's recommendations. Coverage must be uniform and complete. Following germination of the seed, areas lacking germination larger than 20 cm x 20 cm (8" x 8") must be reseeded immediately. Seeded areas must be fertilized and kept moist during development of the turf plants.). DO NOT DRIVE ON SYSTEM: Hydroseeded/hydro-mulch areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

OR

2. Install thin sod directly over sand filled rings, filled no higher than the top of the rings. Sod strips should be placed with very tight joints. Sodded areas must be fertilized and kept moist during root establishment (minimum of 3 weeks). DO NOT DRIVE ON SYSTEM: Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

OR

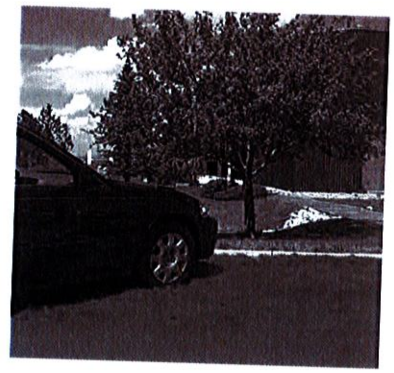
3. Install grass seed at rates per grass type. A light "dusting" of commercial topsoil mix, not to exceed 1/2" (25 mm) will be placed above the rings and seed mix to aid germination rates. Seeded

areas must be fertilized and kept moist during development of the turf plants). DO NOT DRIVE ON SYSTEM: Seeded areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

B. Adequately water sod or grass seed to assure germination of seed and growth of root system.

Protection

Choose **one** paragraph below to match grass installation method.



A. Seeded areas must be protected from any traffic, other than emergency vehicles, for a period of 4 to 8 weeks, or until the grass is mature to handle traffic.

B. Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated below the Grasspave2 units.

Field Quality Control

A. Remove and replace segments of Grasspave2 units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

INVISIBLE STRUCTURES

Invisible Structures, Inc.
303.233.8383
www.invisibelstructures.com

Porosity, Permeability and Infiltration

Permeability – the rate at which a fluid flows through a porous substance under given conditions.

Porosity (void space) – the portion of a volume of material that is not solid

Infiltration – movement of a fluid into the surface of a porous substance.

Infiltration and Permeability are used interchangeably in reference materials

The ***Permeability*** (infiltration) of **Grasspave2**

Sand permeability = 8.27 inches/hour
Grass in Sand root zone= 9 to 25 inches per hour (various USGA mixes)
Base course poor draining = 2.63 inches/hour* (sandstone with 10% fines) Base course common = 7.37 inches /hour* (limestone with 3% fines)
Base course mixed = 38.55 inches /hour***** (66% GP and 33% GW) Subsoils need to infiltrate at least 0.5 in/hr to be considered permeable**

Our system would deliver **2.63 to 38.55** inches of water per hour to the subsoils.

The ***Permeability*** (infiltration) of **Gravelpave2**

Open graded aggregate, 1/4" = 2500 inches/hour***
0.1" to .2" inside open-celled grids = 40+ inches per hour****
Base course poor draining = 2.63 inches/hour* (sandstone with 10% fines)
Base course common = 7.37 inches /hour* (limestone with 3% fines)
Base course mixed = 38.55 inches /hour***** (66% GP and 33% GW)
Subsoils need to infiltrate at least 0.5 in/hr to be considered permeable** and recommended soils would be loam, sandy loam, or loamy sand.

Our system would **2.63 to 38.55** inches of water per hour to the subsoils

The ***Porosity*** (void space) and Water Storage of **Grasspave2**

13 inch cross-section
One inch Grasspave2 with Sand = 20% void
12 inches base course = 20% void (16%-and-up depending on composition)
13 inches x approx. 20% void space =
2.6 cubic inches of Water Storage

The ***Porosity*** (void space) and Water Storage of **Gravelpave2**

13 inch cross-section
One inch of Gravelpave2 with Open Graded Aggregate at 3/16" – 3/8" = 35%
12 inches base course = 20% void (16-35% depending on composition)
(One inch x 35%) + (12 inches at 20%) =
2.75 cubic inches of Water Storage

GW = Well graded, clean gravels, gravel/sand mixtures
GP = Poorly graded, clean gravels, gravel sand mixtures

All rates are approximate and actual installed rates will vary depending on local materials and other conditions.

If existing site soils infiltration rates are below .5 in hr (silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay), additional drainage is recommended below Grasspave2 and Gravelpave2.

**Permeability of Pavement Base Course*, SAM I. THORNTON & CHIN LEONG TOH, Civil Engineering Department, University of Arkansas, May 1995

**Guidelines set by the EPA

***AASHTO, 1993, p I-19, extracted from page 144, Porous Pavement, Bruce Ferguson, Taylor and Francis, 2005.

**** Pratt et al 1995 extracted from page 144, Porous Pavement, Bruce Ferguson, Taylor and Francis, 2005.

***** Data from "Civil Engineering Design Manual", 1995

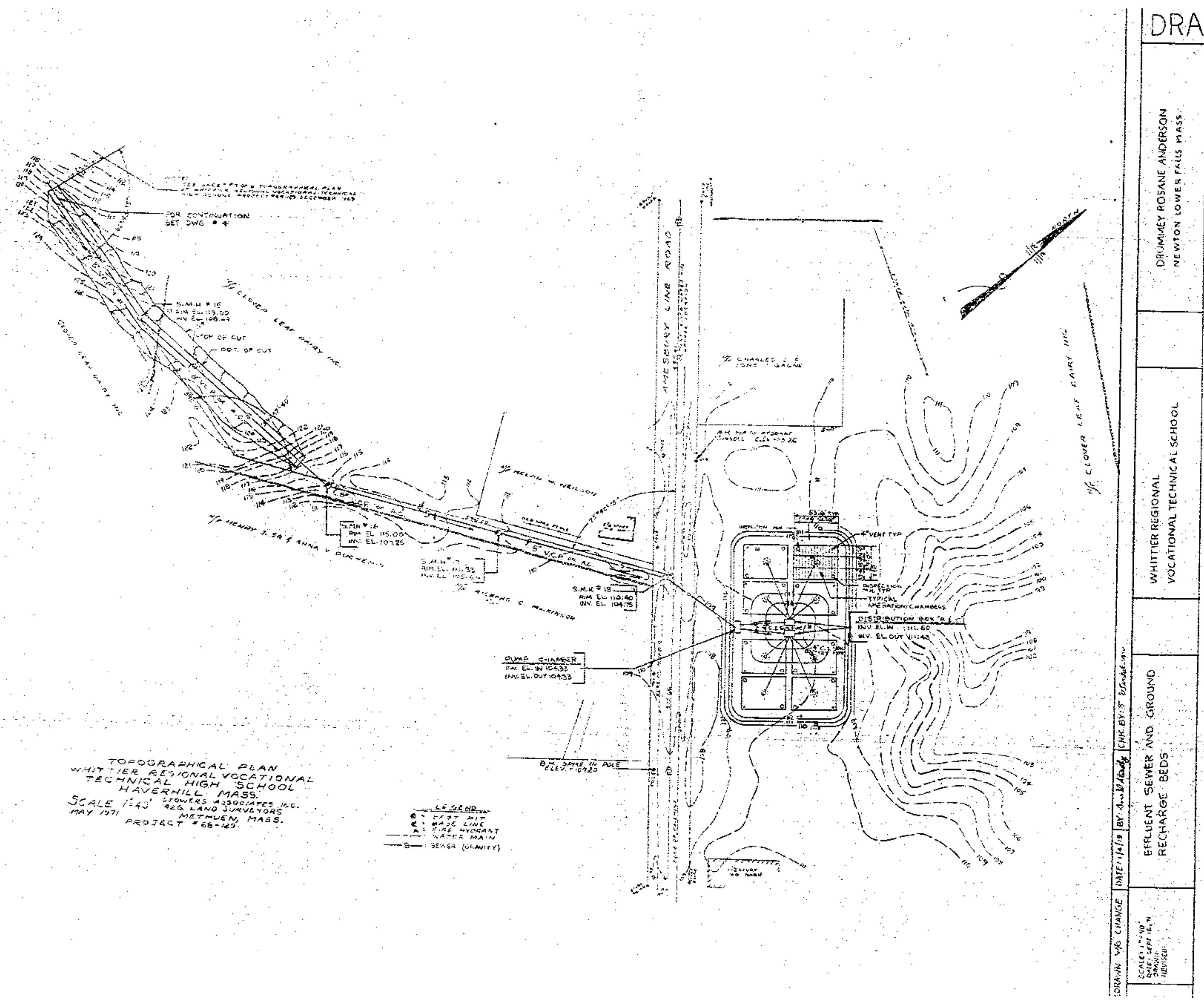
Soil Permeability Rates

Data from "Civil Engineering Design Manual", 1995.

Soil Type	Coeff cm/sec	Rate cm/sec	Rate in/min	Rate in/hr	Description
GW	2.5 EE -2	0.16	3.78	226.77	Well graded, clean gravels, gravel/sand mixtures
GP	5 EE -2	0.04	0.94	56.69	Poorly graded, clean gravels, gravel/sand mixtures
SW	5 EE -4	0.0016	0.04	2.27	Well graded, clean sands, gravely sands
SP	5 EE -4	0.0016	0.04	2.27	poorly graded, clean sands, sand/gravel mix

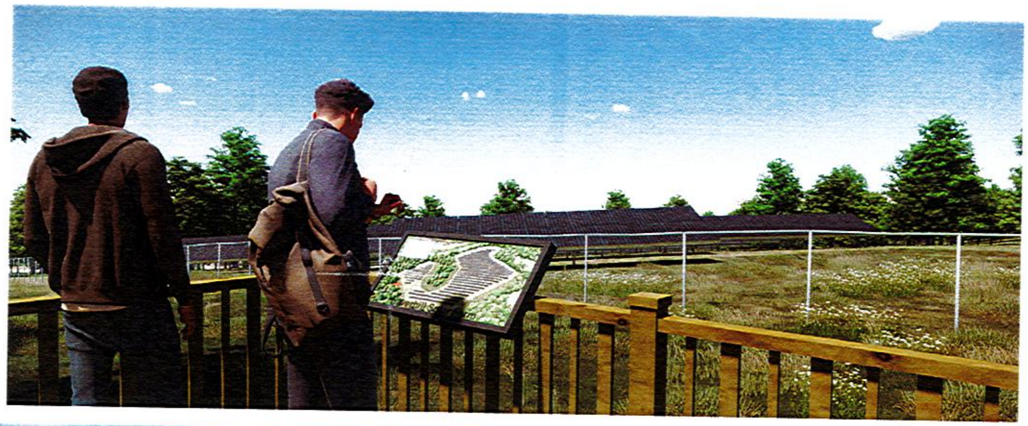
Best base course for GP2 and GV2 would be mix of 2/3GP and 1/3GW

Rate cm/sec	Rate in/min	Rate in/hr
0.0272	0.64	38.55

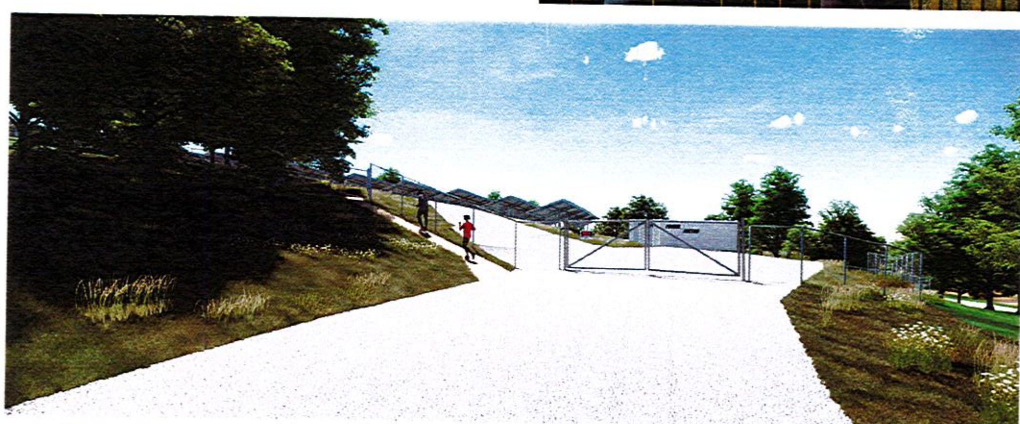


DRA
DRUMMEY ROSANE ANDERSON
NEWTON LOWER FALLS MASS.
WHITTIER REGIONAL
VOCATIONAL TECHNICAL SCHOOL
EFFLUENT SEWER AND GROUND
RECHARGE BEDS
DRAWN N/C CHANGE
NORTH
FOR CONTINUATION SEE DWG # 4
S.M.H. # 16
TOP OF CUT
BOT. OF CUT
CLOVER LEAF DAIRY INC.
S.M.H. # 16 RIM EL. 115.05 INV. EL. 107.25
S.M.H. # 18 RIM EL. 110.40 INV. EL. 104.75
5" V.C.P.
AMESBURY LINE ROAD
CHARLES J. & JOAN J. GAGNE
MELVIN W. NEILSON
RICHARD C. McKINNON
HENRY S. SR & ANNA V. DUCHESNE
PUMP CHAMBER
DISTRIBUTION BOX
TYPICAL AERATION CHAMBERS
VENT TYP.
B.M. SPIKE IN POLE ELEV. 109.20
TOPOGRAPHICAL PLAN
WHITTIER REGIONAL VOCATIONAL
TECHNICAL HIGH SCHOOL
HAVERHILL MASS.
SCALE 1"=40'
MAY 1971
STOWERS ASSOCIATES INC.
REG. LAND SURVEYORS
METHUEN, MASS.
PROJECT # 68-129
LEGEND
TEST PIT
BASE LINE
FIRE HYDRANT
WATER MAIN
SEWER (GRAVITY)

ILLUSTRATIVE VIEW FROM WEST EDUCATION PLATFORM
PROVIDED BY ANDREW STREIT OF POWER FACTOR



ILLUSTRATIVE VIEW FROM EAST EDUCATION PLATFORM
PROVIDED BY ANDREW STREIT OF POWER FACTOR



ILLUSTRATIVE VIEW ENTERING MAIN GATE
PROVIDED BY ANDREW STREIT OF POWER FACTOR

DRAWING ISSUED FOR:

[ ] CONCEPT [ ] CONSTRUCTION
■ PERMIT [ ] CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION, LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES, DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION

GPR Engineering Solutions for Land & Structures

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39 MAIN STREET, SUITE 301, AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978.772.1590 FAX: 978.772.1591
www.gpr-inc.com

SOLAR PHOTOVOLTAIC PROJECT

SOLAR FARM ILLUSTRATIVES

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: [illegible] CHK. BY: AFD	DATE: APRIL 2021	JOB: 181084	SOL-1

SITE PLAN

HAVERHILL SOLAR PROJECT

HAVERHILL, MA

REGULATORY NOTES

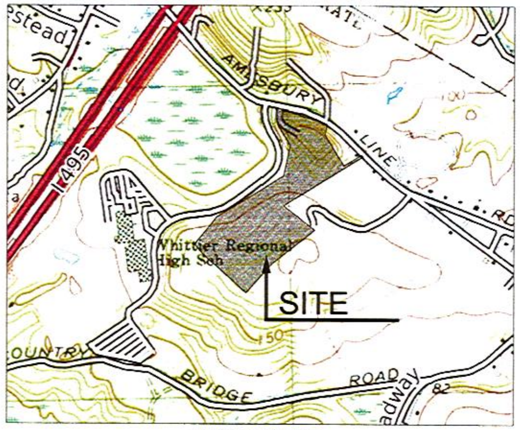
1. CONTRACTOR SHALL CONTACT DIG-SAFE FOR UNDERGROUND UTILITY MARKING AT 888.344.7233 AT LEAST 72 HOURS PRIOR TO COMMENCEMENT OF ANY WORK. CONTRACTOR SHALL GIVE TWENTY-FOUR (24)-HOUR NOTICE TO PERTINENT TOWN DEPARTMENTS BEFORE COMMENCING ANY WORK IN THE FIELD.
2. CONTRACTOR SHALL COORDINATE AND OBTAIN ALL CONSTRUCTION PERMITS REQUIRED BY REGULATORY AUTHORITIES. INSPECTIONS OF DRIVEWAY AND DRAINAGE CONSTRUCTION AT CURRENT INSPECTION FEE RATES IS REQUIRED.
3. CONTRACTOR SHALL BE AWARE OF ALL CONSTRUCTION REQUIREMENTS, CONDITIONS, AND LIMITATIONS IMPOSED BY PERMITS AND APPROVALS ISSUED BY REGULATORY AUTHORITIES PRIOR TO COMMENCEMENT OF ANY WORK.
4. GENERAL COMPLIANCE WITH 28 CFR PART 36 - 2010 ADA STANDARDS FOR ACCESSIBLE DESIGN AND 521 CMR PART C, EXTERIOR OF THE MASSACHUSETTS ARCHITECTURAL ACCESS BOARD REGULATIONS IS INTENDED. CONTRACTOR SHALL VERIFY COMPLIANCE DURING CONSTRUCTION AND SHALL NOTIFY THE OWNER OF ANY NON-COMPLIANCE ISSUES AS SOON AS DISCOVERED.
5. LEDGE REMOVAL VIA BLASTING SHALL CONFORM TO 527 CMR 1.00 AND INCORPORATE THE HAVERHILL FIRE DEPARTMENT LEDGE BLASTING SPECIFICATIONS.

SITE DATA

LOT AREA:	26.8 ±AC. (1,167,844 S.F.)
OPEN SPACE:	93% ±
SOLAR LEASE AREA:	18.6 ± AC (810,801 S.F.)

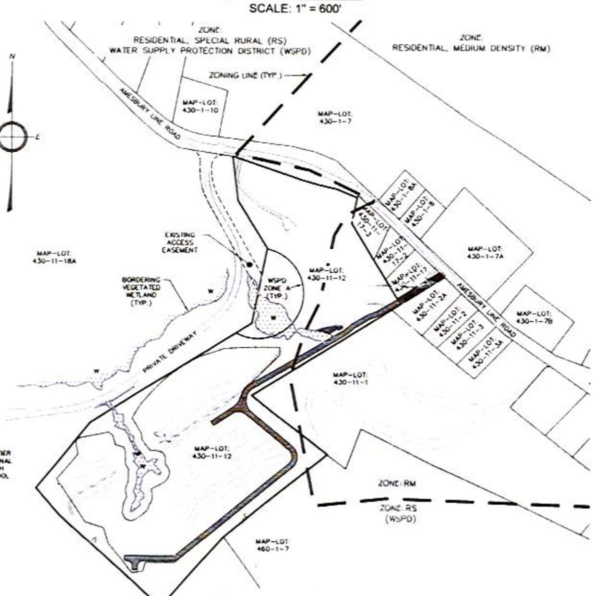
GENERAL NOTES

1. THE INTENT OF THIS SITE PLAN IS TO INSTALL A LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM, DRIVEWAY ENTRANCE AND DRIVEWAY WITH ALL REQUISITE FENCING, STORMWATER MANAGEMENT, AND OTHER APPROPRIATE INFRASTRUCTURE. THE DRIVEWAY WILL BE USED FOR ON-GOING, INFREQUENT ACCESS BY VEHICLES FOR THE PURPOSE OF ROUTINE MAINTENANCE OF THE SOLAR SYSTEM, AS WELL AS FOR EMERGENCY ACCESS.
2. UNDERGROUND POWER LINES ARE PROPOSED FOR THE ELECTRICAL INTERCONNECTION, SUBJECT TO FINAL ENGINEERING BY NATIONAL GRID.
3. LOCATIONS OF EXISTING UNDERGROUND UTILITIES/OBSTRUCTIONS/SYSTEMS SHOWN HEREON ARE APPROXIMATE ONLY. ALL UTILITIES/OBSTRUCTIONS/SYSTEMS MAY NOT BE SHOWN. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL UNDERGROUND UTILITIES/OBSTRUCTIONS/SYSTEMS, WHETHER OR NOT SHOWN HEREON.
4. UNLESS OTHERWISE SHOWN, ALL NEW UTILITIES SHALL BE UNDERGROUND.
5. BURIED UTILITIES SHALL BE INSTALLED IN ACCORDANCE WITH THEIR RESPECTIVE COMPANY SPECIFICATIONS.
6. CONSTRUCTION LAYOUT OF SITE IMPROVEMENTS SHALL BE PERFORMED BY A LICENSED PROFESSIONAL LAND SURVEYOR. LOCATIONS OF EXISTING FEATURES OR PROPOSED IMPROVEMENTS DERIVED BY SCALING DRAWINGS MAY NOT BE ACCURATE. SEE PLAN REFERENCES HEREON.
7. SAFETY MEASURES, CONSTRUCTION METHODS, AND CONTROL OF WORK SHALL BE RESPONSIBILITY OF CONTRACTOR.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR AND/OR REPLACEMENT OF ANY EXISTING UTILITY OR STRUCTURE DAMAGED DURING CONSTRUCTION THAT ARE NOT DESIGNATED FOR DEMOLITION AND/OR REMOVAL HEREON. DAMAGED UTILITY OR STRUCTURE SHALL BE REPAIRED TO THE SATISFACTION OF THEIR RESPECTIVE OWNERS.
9. ANY INTENDED REVISION OF THE HORIZONTAL AND/OR VERTICAL LOCATION OF IMPROVEMENTS TO BE CONSTRUCTED AS SHOWN HEREON SHALL BE REVIEWED AND APPROVED BY ENGINEER PRIOR TO IMPLEMENTATION.
10. CONTRACTOR SHALL NOTIFY ENGINEER UPON COMMENCEMENT OF CONSTRUCTION IN ORDER TO ENSURE THAT REQUIRED INSPECTIONS ARE PERFORMED IN A TIMELY AND EFFICIENT MANNER.
11. CONTRACTOR SHALL PROMPTLY NOTIFY ENGINEER UPON DISCOVERY OF ANY UNFORESEEN SURFACE OR SUBSURFACE CONDITIONS THAT MAY IMPACT SITE CONSTRUCTION.
12. FINISH RIM ELEVATIONS SHOULD MATCH PAVEMENT, GRADING OR LANDSCAPING, UNLESS SPECIFICALLY INDICATED OTHERWISE.
13. WHERE EXISTING UTILITY LINES/STRUCTURES ARE TO BE CUT/BROKEN DOWN/ABANDONED, LINES/STRUCTURES SHALL BE PLUGGED/CAPPED/FILLED IN ACCORDANCE WITH UTILITY OWNER REQUIREMENTS.
14. EROSION CONTROL MEASURES, SUCH AS SILT FENCE OR STRAW BALES AS MAY BE SHOWN HEREON, SHALL BE INSTALLED BEFORE EARTH DISTURBANCE OCCURS, AND SHALL SERVE AS THE LIMIT OF WORK.
15. WHERE THE WORD "INSTALL" IS USED HEREIN, IT IS INTENDED TO DIRECT CONTRACTOR TO "FURNISH, INSTALL, AND PLACE IN OPERATION" THE COMPONENT REFERRED TO.
16. LIMITS OF WORK SHALL BE STAKED IN THE FIELD PRIOR TO COMMENCEMENT OF CONSTRUCTION.
17. ALL STORM DRAIN PIPE TO BE SMOOTH INTERIOR HDPE PIPE, 2.0 PSI GASKETED JOINT, UNLESS OTHERWISE NOTED.
18. WHERE SHOWN, CONSTRUCTION NOTES ARE INTENDED TO SUMMARIZE AND CLARIFY MAJOR ITEMS OF WORK. THESE NOTES SHOULD NOT BE CONSTRUED AS AN EXHAUSTIVE LISTING OF ALL WORK REQUIRED. CONTRACTOR SHOULD CONTACT ENGINEER WHEN FURTHER CLARIFICATION OF DEPICTED WORK IS DESIRED.
19. NO DEBRIS, JUNK, RUBBISH OR OTHER NON-BIODEGRADABLE MATERIALS, FILL CONTAINING HAZARDOUS MATERIALS OR WASTES, OR STUMPS SHALL BE BURIED ON ANY LAND ON THIS SITE, OR LEFT ON ANY LOT OR ON THE STREET RIGHT OF WAY.



VICINITY MAP

SCALE: 1" = 600'



OVERALL MAP & ZONING

SCALE: 1" = 250'

SHEET INDEX

ASSESSORS REFERENCE

ASSESSORS MAP 430, BLOCK 11, LOT 12

SUBMITTALS

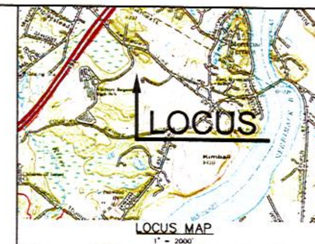
1. COORDINATE POWER AND COMMUNICATIONS SERVICE WITH UTILITY COMPANIES. SUBMIT UTILITY GENERATED LAYOUT PLAN(S) TO ENGINEER FOR APPROVAL PRIOR TO ANY CONSTRUCTION.
2. SPECIAL PERMIT TO CITY COUNCIL FOR CONSTRUCTION OF LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM.
3. SPECIAL PERMIT TO CITY COUNCIL FOR CONSTRUCTION IN WATER SUPPLY PROTECTION DISTRICT (WSPD).
4. SUBMIT SITE PLAN TO CITY OF HAVERHILL DEVELOPMENT REVIEW FOR CONSTRUCTION OF LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM.
5. SUBMIT NOTICE OF INTENT TO CITY OF HAVERHILL CONSERVATION COMMISSION FOR REVIEW FOR WORK THAT FALLS UNDER THE MASSACHUSETTS WETLAND PROTECTION ACT AND CITY OF HAVERHILL WETLAND PROTECTION ORDINANCE.

ZONING

Parameter	Section [1]	Requirement	Remarks
Zoning District	2.1.1 & Zoning Map	RS / RM	Special Rural (residential) & medium density (residential)
Overlay District	2.1.2 & Zoning Map	WSPD	WSPD (Water Supply Protection District)
			9.2.7
Proposed Use	7.8.3	Allowed by SPGA	Large-Scale Ground-Mounted Solar Energy Systems
		RS / RM	
Lot Area	Appendix B-Table 2	87,120 SF / 20,000 SF	1,167,844 SF
Frontage	Appendix B-Table 2	200 FT / 150 FT	583 FT
Lot Depth	Appendix B-Table 2	150 FT / 100 FT	1900 FT
Yard	Appendix B-Table 2	Special / residential / solar	Use Solar Dimensions
Front	Appendix B-Table 2	40 FT / 25 FT / 100 FT	100 FT (7.8.6-1 a.)
Side	Appendix B-Table 2	25 FT / 15 FT / 100 FT	100 FT (7.8.6-1 b.)
Rear	Appendix B-Table 2	25 FT / 30 FT / 100 FT	100 FT (7.8.6-1 c.)
Building Height	Appendix B-Table 2	35 FT / 35 FT	N/A
Maximum Stories	Appendix B-Table 2	2.5 / 2.5	N/A
Building Coverage	Appendix B-Table 2	15 % / 25 %	N/A
Floor Area Ratio	Appendix B-Table 2	None	N/A
Open Space (MIN.)	Appendix B-Table 2	70 % / 45 %	93.95%
Parking	9.3.15	see table	
Driveways and Entrances	7.8.7	see bylaw	
Wetlands Setback	253-8	100 feet from resource area	35' no disturbance, 75' no structure
Zone A, B, C	255-18		See Resource Impact Map (sheet C3.2)
MDEP Riverfront Area	N/A		none on site
FEMA Floodplain	25009C0092F		none on site
ACEC	N/A		none on site
NHESP	N/A		none on site
Zone 1 Protective Radius	N/A		none on site
Mapped Zone 2	N/A		none on site
IWPA	N/A		none on site

NOTES:
[1] Reference to section of Zoning Bylaw, where applicable.

ABBREVIATIONS:
SF=square feet; CF=cubic feet; FT=feet; GFA=gross floor area; GPD=gallons per day; AC=acres;
WSPD=Water Supply Protection District, ZBA=Zoning Board of Appeals; SPGA=Special Permit Granting Authority



LOCUS MAP
1" = 2000'

ELEVATION DATUM
DATUM: NAVD 1988
BM NO.1

EXISTING CONDITIONS NOTES:
1. EXISTING CONDITION INFORMATION BASED ON AN ON-THE-GROUND TOPOGRAPHIC AND BOUNDARY SURVEY PERFORMED BY GOLDSMITH, PREST & RINGWALL, INC. OCTOBER 2020.
2. EDGE OF WETLAND DELINEATED BY MATTHEW MARRO-PRINCIPAL CONSULTANT OF MATTHEW S. MARRO ENVIRONMENTAL CONSULTING, DATED OCTOBER 2020.

PLAN REFERENCES
A. "EFFLUENT SEWER AND GROUND RECHARGE BEDS" BY DRUMMEY ROSANE ANDERSON (DRA) OF NEWTON LOWER MASS. DATED 1/4/79, PROVIDED BY WHITTIER SCHOOL.

DRAWING ISSUED FOR:
☐ CONCEPT ☐ CONSTRUCTION
■ PERMIT ☐ CONSTRUCTION RECORD

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COMMONWEALTH OF MASSACHUSETTS
KYLE BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED PROFESSIONAL ENGINEER
8/16/21

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION; LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES; DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS

GPR
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www.gpr-inc.com

SOLAR PHOTOVOLTAIC PROJECT

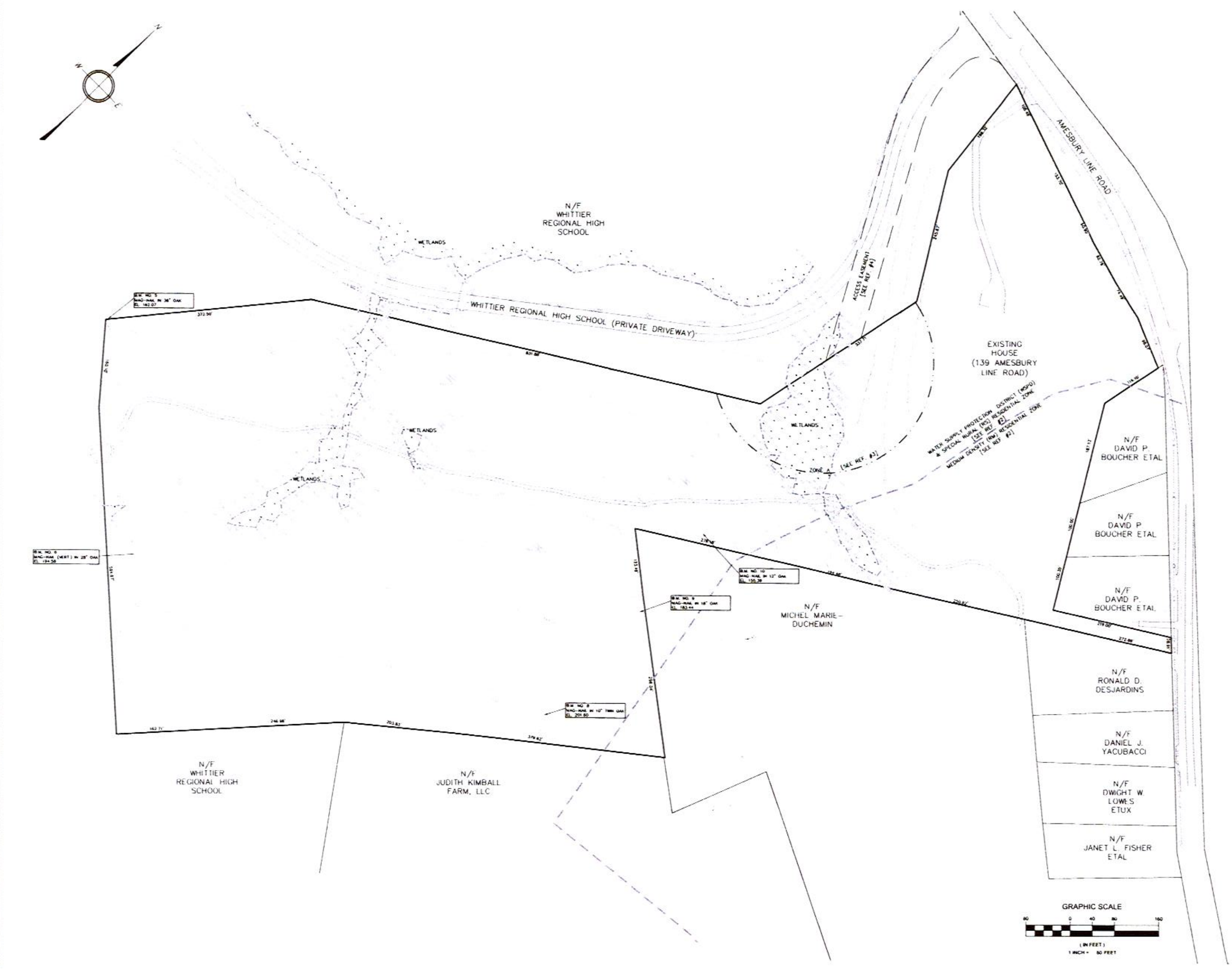
TITLE SHEET

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB / CHK. BY: KFB	DATE: APRIL 2021	JOB 181084	C1.1

P:\18---\181084\DWG\PERMIT\SOLAR SITE-REV1.DWG 08-16-21 11:59:50 AM - LAYOUT: C1.1 TITLE



LEGEND

EXISTING

- ELEVATION CONTOUR
- SPOT GRADE
- PROPERTY LINE
- WETLAND DELINEATION
- EDGE OF PAVEMENT
- GRAVEL/DIRT TRAIL
- CAPE COD BERM CURBING
- STONE WALL
- WATER VALVE
- FIRE HYDRANT
- GRAVITY SEWER LINE
- SEWER MANHOLE
- OVERHEAD POWER LINE
- UTILITY POLE
- STORM DRAIN
- DRAIN MANHOLE
- DEEP SOIL OBSERVATION HOLE
- ELEVATION BENCHMARK
- EDGE OF TREELINE

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

PLAN REFERENCES

1. "PLAN OF LAND IN HAVERHILL, MASS." DRAWN FOR THEODORE XENAKIS BY MERRIMACK ENGINEERING SERVICES. DATED DECEMBER 1981. ESSEX DISTRICT REGISTRY OF DEEDS PLAN BOOK 176, PLAN 36.
2. "CITY OF HAVERHILL MASSACHUSETTS ZONING WITH WATERSHED & INDEX MAP-2017" BASED ON PLAN OVERLAY PROVIDED BY THE HAVERHILL DEPARTMENT OF ECONOMIC DEVELOPMENT & PLANNING.
3. EDGE OF ZONE A BASED ON PLAN OVERLAY PROVIDED BY OLIVER: MASS GIS.
4. "PLAN OF LAND IN HAVERHILL MASS SHOWING EASEMENT LOCATION" PREPARED BY STOWERS ASSOCIATES REG LAND SURVEYORS. DATED MARCH 1970. ESSEX REGISTRY OF DEEDS PLAN BOOK 116 PLAN 76.

ASSESSORS REFERENCE:

ASSESSORS MAP 430, PARCEL 11, LOT 12, 26.8 ACRES

EXISTING CONDITIONS NOTES:

1. EXISTING CONDITION INFORMATION BASED ON AN ON-THE-GROUND TOPOGRAPHIC AND BOUNDARY SURVEY PERFORMED BY GOLDSMITH, PREST & RINGWALL, INC. OCTOBER 2020.
2. EDGE OF WETLAND DELINEATED BY MATTHEW MARRO-PRINCIPAL CONSULTANT OF MATTHEW S. MARRO ENVIRONMENTAL CONSULTING, DATED OCTOBER 2020, AND MODIFIED BY MARY RIMMER OF RIMMER ENVIRONMENTAL CONSULTING, LLC IN JULY 2021. ALL WETLAND DELINEATION FLAGS SURVEYED BY GPR IN OCTOBER 2020 AND JULY 2021.

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION

■ PERMIT ☐ CONSTRUCTION RECORD

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8/11/2021

NO.	DATE	BY	APP	REVISION DESCRIPTION
1	8/11/2021	JFB	KFB	REVIEW COMMENTS & ADDED WETLAND AREAS

GPR Engineering Solutions for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.
39 MAIN STREET, SUITE 301 AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978 772 1590 FAX: 978 772 1591
www.gpr-inc.com

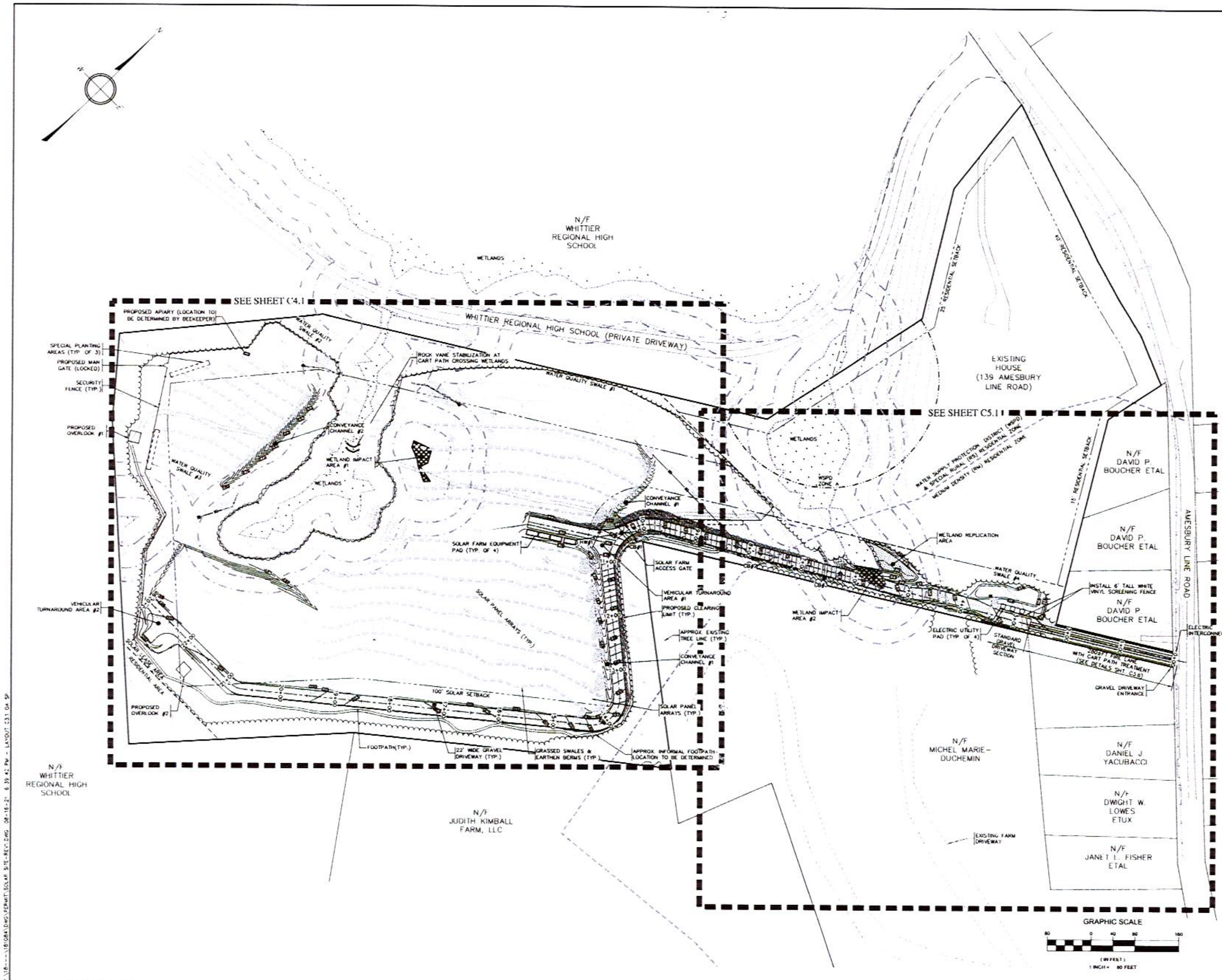
SOLAR PHOTOVOLTAIC PROJECT

EXISTING CONDITIONS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: KFB / CHK. BY: DJD	DATE:	APRIL 2021	JOB 181084	C2.1



LEGEND

EXISTING		PROPOSED
	ELEVATION CONTOUR	
	SPOT GRADE	
	PROPERTY LINE	
	WETLAND DELINEATION	
	WETLAND BUFFER ZONE	
	SHORELINE	
	SOLAR LEASE AREA	
	PROPERTY LINE SETBACK	
	100-YEAR FLOODPLAIN LIMIT	
	EDGE OF PAVEMENT	
	CAPE COD BERM CURBING	
	GRANITE CURBING	
	GRAVEL/DIRT ROAD	
	STOCKADE FENCE	
	STONE WALL	
	WATER MAIN	W
	WATER SERVICE	WS
	FIRE SERVICE	FS
	WATER VALVE	WV
	FIRE HYDRANT	
	FORCE MAIN	FM
	GRAVITY SEWER LINE	SS
	SEWER MANHOLE	SMH
	GAS LINE	
	GAS SERVICE	GS
	GAS VALVE	
	BURIED POWER LINE	E
	OVERHEAD POWER LINE	
	UTILITY POLE	
	GUY WIRE	
	ELECTRIC BOX	E
	STORM DRAIN	SD
	UNDERDRAIN	UD
	ROOF DRAIN	RD
	FOUNDATION DRAIN	FD
	CATCH BASIN	
	DRAIN MANHOLE	
	DEEP SOIL OBSERVATION HOLE	
	MAILBOX	
	SITE LUMINAIRE	
	SIGN	
	ELEVATION BENCHMARK	
	SURFACE RUNOFF DIRECTION	
	STONE BOUND	
	DRILL HOLE	
	IRON ROD	

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

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KYLE BURCHARD CIVIL ENGINEER NO. 54147

8/16/21

PER 250 CMR 5.0X(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION; LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES; DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION
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SOLAR PHOTOVOLTAIC PROJECT

OVERALL SITE PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE	APRIL 2021	JOB 181084	C3.1
CHK. BY: KFB				

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RESOURCE IMPACT MAP LEGEND

- 35'-75' WETLAND BUFFER ALTERATION
- 75'-100' WETLAND BUFFER ALTERATION
- TREE AND VEGETATION REMOVAL

RESOURCE IMPACT SUMMARY

BVW AREAS

AREA #1	1,185 S.F.
AREA #2	1,320 S.F.
TOTAL	2,505 S.F.

BUFFER IMPACT SUMMARY

0'-35' WETLAND BUFFER	
AREA #1	10,581 S.F.
AREA #2	7,193 S.F.
35'-75' WETLAND BUFFER	
AREA #1	62,294 S.F.
AREA #2	11,586 S.F.
75'-100' WETLAND BUFFER	
AREA #1	44,111 S.F.
AREA #2	8,186 S.F.
TOTAL	143,801 S.F.

WSPD IMPACT SUMMARY

WSPD ZONE A	
DISTURBED AREA	0
WSPD ZONE C	
DISTURBED AREA	603,375 S.F.
TOTAL	603,375 S.F.

TREE IMPACT SUMMARY

TREES 10" DBH OR GREATER TO BE REMOVED

TOTAL 715 TREES

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COMMONWEALTH OF MASSACHUSETTS
KYLE BURCHARD
CIVIL ENGINEER
NO 54147
REGISTERED PROFESSIONAL ENGINEER

8/16/21

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SOLAR PHOTOVOLTAIC PROJECT

RESOURCE IMPACT MAP

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
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1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C3.2
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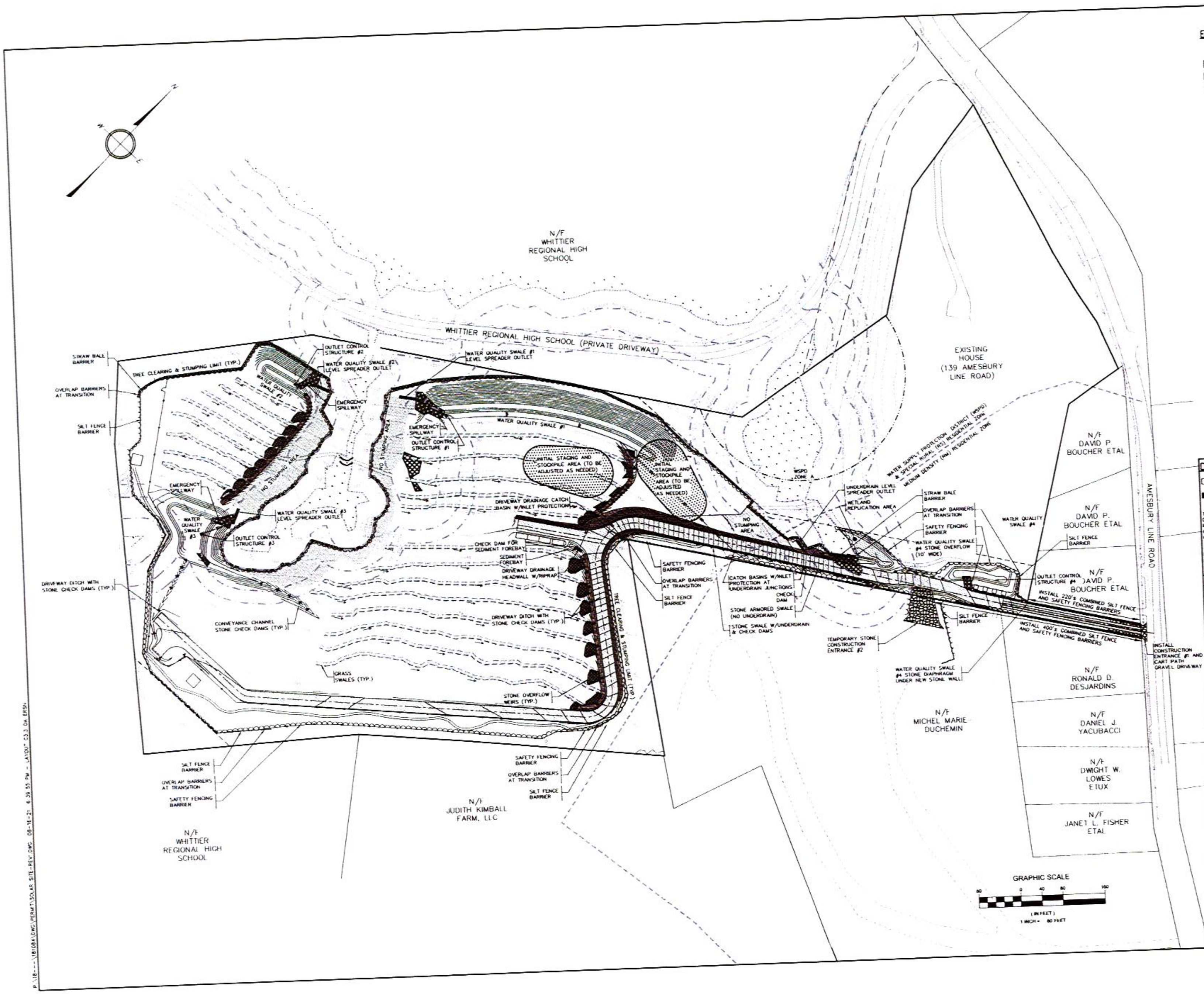

EROSION AND SEDIMENT MAP LEGEND

- PROPOSED "NO STUMPING" AREA
- PROPOSED DRIVEWAY
- PROPOSED GRASS SWALE

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SOLAR PHOTOVOLTAIC PROJECT

EROSION AND SEDIMENT CONTROL PLAN

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EROSION AND SEDIMENT CONTROL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. FURNISH, INSTALL, AND MAINTAIN TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES ACROSS ALL AND EVERY GROUND SURFACE THAT IS ALTERED BY CONSTRUCTION THAT IS NOT OTHERWISE PERMANENTLY STABILIZED BY PERMANENT DRIVEWAY SURFACES. TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES SHALL CONSIST OF, BUT NOT NECESSARILY LIMITED TO, STRAW BALE AND SILT FENCE BARRIERS, RIPRAP, SILT BAGS, DIVERSION CHANNELS AND BERMS, BYPASS PUMPS/INTAKE FILTERS/HOSES, CHECK DAMS, STRATEGICALLY LOCATED STOCKPILES, SEDIMENT BASINS, MULCH, LOAM AND SEED MIX (HEREINAFTER "CONTROL MEASURES") ADEQUATE TO PREVENT THE CONVEYANCE OF EROSION PRODUCTS (E.G. SOIL, MULCH, SOD) OFF SITE, OR INTO ENVIRONMENTALLY SENSITIVE AREAS, OR INTO AREAS WHERE WORK WILL BE ADVERSELY IMPACTED. ENVIRONMENTALLY SENSITIVE AREAS INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, WETLANDS, TRIBUTARIES TO WETLANDS, WETLAND BUFFER ZONES, INTERMITTENT AND PERENNIAL STREAMS / RIVERS, AND THEIR ATTENDANT BUFFER ZONES.

1. REFER TO DRAWINGS FOR LOCATION AND DETAILS OF CONTROL MEASURES REQUIRED TO COMMENCE WORK. THESE CONTROL MEASURES WILL BE ADEQUATE ONLY FOR VEGETATION CLEARING. THE DRAWINGS ARE NOT INTENDED TO GRAPHICALLY DEPICT ALL CONTROL MEASURES THAT WILL BE REQUIRED TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A.
2. DEVISE AND EMPLOY CONTROL MEASURES THROUGHOUT THE DURATION OF PROJECT, OVER ALL AREAS DISTURBED OR UNDISTURBED BY CONSTRUCTION, AS NECESSARY TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A.
3. DEVISE AND EMPLOY TEMPORARY CONTROL MEASURES AS NECESSARY TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A, WHILE ALLOWING WORK TO PROCEED IN AN EFFICIENT, COST EFFECTIVE MANNER.
4. DEVISE, EMPLOY AND MAINTAIN CONTROL MEASURES UNTIL SUCH TIME AS THE ENTIRE SITE IS PERMANENTLY STABILIZED BY ESTABLISHED VEGETATION, FINISH LANDSCAPE MATERIALS, PAVED SURFACES, AND/OR ROOF AREA.
5. ONCE THE SITE IS PERMANENTLY STABILIZED AND CERTIFIED AS SUCH BY ENGINEER, REMOVE TEMPORARY CONTROL MEASURES WHILE PROTECTING STABILIZED SURFACES.

1.02 SUBMITTALS

A. SUBMIT PRODUCT DATA, WARRANTY, AND TEST REPORTS AS INDICATED ON THE DRAWINGS.

B. DUE TO THE SIZE OF THE PROJECT AND MORE THAN 1 ACRE OF LAND DISTURBANCE, A CONSTRUCTION GENERAL PERMIT (CGP) IS REQUIRED TO BE FILED WITH THE US ENVIRONMENTAL PROTECTION AGENCY (EPA) UNDER ITS NON-POINT DISCHARGE ELIMINATION SYSTEM (NPDES) PROGRAM, CONSISTING OF AT MINIMUM, AN NPDES NOTICE OF INTENT AND A STORMWATER POLLUTION PREVENTION PLAN (SWPPP).

1.03 QUALITY ASSURANCE

A. COMPLY WITH GOVERNING CODES AND REGULATIONS. PROVIDE PRODUCTS FROM ACCEPTABLE MANUFACTURERS. USE EXPERIENCED INSTALLERS. DELIVER, HANDLE, AND STORE MATERIALS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.

B. CONFORM TO CONDITIONS OF APPROVAL ISSUED BY REGULATORY AGENCIES INCLUDING, BUT NOT NECESSARILY LIMITED TO, LOCAL PLANNING BOARD, CONSERVATION COMMISSION, BOARD OF SELECTMEN, BOARD OF HEALTH, PUBLIC WORKS / HIGHWAY DEPARTMENT, STATE ENVIRONMENTAL PROTECTION DEPARTMENT, AND U.S. GOVERNMENT, ENVIRONMENTAL PROTECTION AGENCY. WHERE CONDITIONS OF REGULATORY APPROVAL DIFFER FROM REQUIREMENTS CONTAINED HEREIN OR ON THE DRAWINGS, COMPLY WITH THE MORE STRINGENT REQUIREMENT.

PART 2 – PRODUCTS

2.01 MATERIALS

A. STRAW BALES: MACHINE BOUND WITH JUTE OR WIRE, APPROXIMATE SIZE EACH BALE 42" x 16" x 16"

B. SILT FENCE: NON-WOVEN, UV-RESISTANT, POLYPROPYLENE FABRIC, FLOW RATED AT 10 GPM/SF MINIMUM, GRAB TENSILE RATED AT 124 POUNDS MINIMUM, WITH INTEGRAL STAKE LOOPS, AND HARDWOOD STAKES. USE NO. 2130 BY AMOCO FABRICS & FIBERS, OR APPROVED EQUAL.

C. MULCH: ORGANICS INCLUDING HAY, PROCESSED PINE / HEMLOCK TWIGS AND NEEDLES.

D. SEED MIXES: PERENNIAL RYEGRASS, KENTUCKY BLUEGRASS, AND / OR FINE FESCUE, DISEASE RESISTANT. NON-MAINTAINED AREA OPTION – ANNUAL RYEGRASS COMBINED WITH MEDIUM RED CLOVER.

E. EXCELSIOR BLANKET: CURLED WOOD FIBER ON PHOTODEGRADABLE EXTRUDED PLASTIC MATRIX, 80% OF FIBERS 6-INCHES LONG OR LONGER, WEIGHT 0.975 POUNDS / SY, CONTAINING NO CHEMICAL ADDITIVES. USE CURLEX I BLANKET BY AMERICAN EXCELSIOR COMPANY, OR APPROVED EQUAL.

F. ROCK RIPRAP: SOUND, ANGULAR, 6-INCH MINUS PROCESSED ROCK, BLAST ROCK, OR TAILINGS.

G. CRUSHED STONE: SOUND, ANGULAR, 2-INCH MINUS PROCESSED CRUSHED STONE.

PART 3 – EXECUTION

3.01 THROUGHOUT CONSTRUCTION

A. DEVISE WORK SEQUENCE SO AS TO LIMIT DRAINAGE AREA THAT IS TRIBUTARY TO DISTURBED AREAS. DEVISE, EMPLOY, AND MAINTAIN CONTROL MEASURES SUCH AS DIVERSION CHANNELS AND BERMS, STRATEGICALLY LOCATED STOCKPILES, AND SEDIMENT BASINS TO SUBDIVIDE DRAINAGE AREAS INTO SMALL, MANAGEABLE SUBAREAS, THEREBY MINIMIZING RUNOFF AND THE POTENTIAL FOR EROSION.

B. MAINTAIN BARRIER AT LIMIT OF WORK AND PROTECT EXISTING VEGETATION / FACILITIES OUTSIDE OF LIMIT OF WORK.

C. MAINTAIN SPARE MATERIAL STOCKPILES FOR IMMEDIATE EMPLOYMENT / REPAIR / EXPANSION OF CONTROL MEASURES. AT A MINIMUM, SUCH MATERIALS SHALL INCLUDE STRAW BALES, SILT FENCE AND STAKES, AND CRUSHED STONE.

D. INSPECT AND MAINTAIN EFFECTIVENESS OF CONTROL MEASURES BY REPAIRING AS NECESSARY TO ENSURE INTENDED FUNCTION, BY SUPPLEMENTING AS NECESSARY FOR ADEQUATE EXTENT, BY REMOVING TRAPPED PRODUCTS OF EROSION AS NECESSARY TO MAINTAIN EFFECTIVE TRAP VOLUME.

E. LIMIT EXTENT OF WORK AREA SO THAT ALL DISTURBED AREAS CAN BE STABILIZED WITH CONTROL MEASURES WITHIN A 24-HOUR PERIOD. IN NO EVENT SHALL A GROUND SURFACE, SLOPE OR STOCKPILE BE LEFT DENUDED FOR MORE THAN 14 DAYS WITHOUT APPLICATION OF TEMPORARY OR PERMANENT SURFACE STABILIZATION PRACTICES.

F. INSTALL CONTROL MEASURES AS SOON AS PRACTICABLE AFTER EACH MANAGEABLE PORTION OF EARTHWORK IS COMPLETE. EMPLOY TEMPORARY MEASURES AS NECESSARY TO STABILIZE DISTURBED AREAS, EVEN WHERE SUBSEQUENT CONSTRUCTION OPERATIONS MAY REQUIRE RE-DISTURBANCE.

G. WHEN INTENSE RAINFALL IS EXPECTED, CONSIDER, DEVISE, AND EMPLOY REINFORCING CONTROL MEASURES PRIOR TO THE RAINFALL EVENT TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A. IF NECESSARY, EMPLOY TEMPORARY CONTROL MEASURES ON MATERIAL STOCKPILES TO COUNTERACT POTENTIAL SEDIMENT TRANSPORT DURING INTENSE RAINFALL.

H. WHEN VEHICLE REFUELING IS REQUIRED ON SITE, CONDUCT REFUELING OPERATIONS OUTSIDE OF ENVIRONMENTALLY SENSITIVE AREAS.

I. PROPERLY DISPOSE OF DEBRIS, SOLID WASTE, TRASH, AND CONSTRUCTION WASTE / BYPRODUCTS OFF SITE.

J. SWEEP ON-SITE PAVED AREAS AND OFF-SITE STREETS AS NECESSARY TO PREVENT SILT AND DEBRIS ORIGINATING ON SITE FROM ENTERING CLOSED DRAINAGE SYSTEMS AND / OR ENVIRONMENTALLY SENSITIVE AREAS.

3.02 SITE PREPARATION AND ACCESS

A. WALK SITE AND IDENTIFY LOCATIONS OF LIMIT OF WORK AND ENVIRONMENTALLY SENSITIVE AREAS. ESTABLISH CONSTRUCTION STAGING AREA, LOCATED BEYOND ENVIRONMENTALLY SENSITIVE AREAS.

B. INSTALL CONTROL MEASURES AS SHOWN ON THE DRAWINGS, INCLUDING THOSE DEFINING THE LIMIT OF WORK.

C. LIMIT VEHICULAR TRAFFIC TO AND FROM SITE TO MINIMIZE TRANSPORT OF SEDIMENT.

3.03 CLEARING, GRUBBING, AND STRIPPING

A. SCHEDULE GRUBBING AND STRIPPING TO OCCUR IMMEDIATELY PRIOR TO EARTH DISTURBANCE. DEPENDING ON SITE AREA, CONSIDER MULTIPLE GRUBBING PHASES, SEQUENCED TO TAKE ADVANTAGE OF THE EROSION PREVENTION POTENTIAL OF EXISTING VEGETATIVE COVER.

B. MINIMIZE THE AREA OF EXISTING VEGETATION REMOVED WHEREVER POSSIBLE.

C. LOCATE AND SIZE STOCKPILES TO MINIMIZE EROSION POTENTIAL, TAKING ADVANTAGE OF TERRAIN SLOPE AND ASPECT, WHERE APPROPRIATE.

D. PROTECT VEGETATION, INCLUDING ROOT SYSTEMS, BEYOND LIMIT OF CLEARING.

E. PROCESS TIMBER, STUMPS, SLASH, AND BRUSH SO AS TO PROTECT ENVIRONMENTALLY SENSITIVE AREAS AND INSTALLED CONTROL MEASURES. PROPERLY DISPOSE OF EXCESS OFF SITE. BURIAL OF STUMPS ON SITE IS PROHIBITED.

3.04 EXCAVATION FOR BUILDING FOUNDATIONS AND UTILITIES

A. DEVISE AND INSTALL CONTROL MEASURES ADEQUATE TO HANDLE DISCHARGES AND TRAP SEDIMENT FROM FOOTING SUMP AND WELL POINT PUMPS PRIOR TO EXCAVATION.

B. ARMOR SUMP PUMP DISCHARGE LOCATIONS TO PREVENT EROSION AT POINT OF DISCHARGE AND AREAS DOWNSTREAM.

C. IF FOUNDATION EXCAVATIONS GRADE TO DAYLIGHT ON THE LOW SIDE, DEVISE AND INSTALL CONTROL MEASURES TO HANDLE SURFACE AND GROUNDWATER FLOW FROM EXCAVATION LOW POINT.

D. STOCKPILE EXCAVATED MATERIALS TO BAFFLE OVERLAND RUNOFF, AVOIDING THE CREATION OF LENGTHY PATHS OF CONCENTRATED RUNOFF.

E. BACKFILL UTILITY TRENCHES AS SOON AS PRACTICABLE TO PREVENT FLOODING, SLOUGHING, POTENTIAL OVERFLOW, AND REPETITIVE EARTH DISTURBANCE.

3.05 SITE GRADING

A. WHERE APPLICABLE, FOLLOW EXCAVATION AND FILL PRACTICES SHOWN ON DRAWINGS TO LOCALIZE AND MINIMIZE EROSION.

B. MONITOR SEDIMENT VOLUME IN TEMPORARY SEDIMENT BASINS AND AT DIVERSION BERMS AND CHECK DAMS. IN ALL AREAS EXCEPT THOSE THAT DO NOT PRESENT POTENTIAL PROBLEMS WITH REGARD TO FUTURE SOIL STABILITY, DRAINAGE, OR BEARING CAPACITY, REMOVE AND PROPERLY DISPOSE OF TRAPPED SEDIMENT BEFORE BRINGING SITE TO FINAL SUBGRADE.

3.06 STORMWATER MANAGEMENT SYSTEM

A. THE STORMWATER MANAGEMENT SYSTEM INCLUDES, BUT IS NOT NECESSARILY LIMITED TO, ALL PERMANENT DETENTION / RETENTION BASINS, DISCHARGE STRUCTURES / WEIRS, CULVERTS, OPEN CHANNELS, CURBS, GUTTERS, PAVED SWALES, CATCH BASINS, DRAIN MANHOLES, DRAINAGE PIPES, ROOF DRAIN MANIFOLDS, WATER QUALITY SWALES, SEPARATORS, AND SIMILAR STORMWATER RUNOFF CONVEYANCE, TREATMENT, AND STORAGE FACILITIES.

B. INSTALL STORMWATER MANAGEMENT SYSTEM COMPONENTS STARTING AT THE DOWNSTREAM END AND PROCEED UPSTREAM. WHERE POSSIBLE, COMPLETE INSTALLATION OF PERMANENT DETENTION / RETENTION BASINS PRIOR TO BEGINNING WORK ON UPSTREAM SYSTEM COMPONENTS.

C. INSTALL CONTROL MEASURES AT FINISHED UPSTREAM AND DOWNSTREAM PIPE ENDS AS SOON AS POSSIBLE AFTER COMPLETION OF PIPE RUN. SUCH MEASURES INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, RIPRAP, CHECK DAMS, STRAW BALE / SILT FENCE BARRIERS, AND VELOCITY DISSIPATORS.

D. AT THE END OF EACH DAY OR WHEN RAINFALL IS EXPECTED, PLUG UPSTREAM END OF PIPES / DAM OPEN CHANNELS OR OTHERWISE REDIRECT POTENTIAL RUNOFF AND PREVENT FLOW FROM ENTERING PARTIALLY COMPLETED SYSTEM / SYSTEM COMPONENTS.

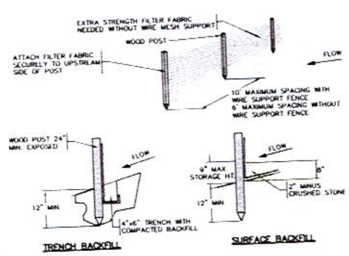
E. WHERE PORTIONS OF A NEW SYSTEM, ESPECIALLY FOR INFILTRATION BASINS, ARE TO BE ACTIVATED PRIOR TO COMPLETION OF THE ENTIRE SYSTEM, EMPLOY CONTROL MEASURES TO PREVENT SILT AND DEBRIS FROM ENTERING THE SYSTEM. EMPLOY SILT SACKS OR FABRIC ON CATCH BASIN INLETS, AND PIPE AND CULVERT OPENINGS. EMPLOY CHECK DAMS AND TEMPORARY SEDIMENT BASINS UPSTREAM OF AND ALONG OPEN CHANNELS, SWALES, AND DITCHES TO TRAP SEDIMENT UPGRADIENT OF ENVIRONMENTALLY SENSITIVE AREAS.

F. REMOVE TRAPPED SEDIMENT AND DEBRIS FROM ALL SYSTEM COMPONENTS AFTER COMPLETION OF INSTALLATION, AND AGAIN AFTER THE ENTIRE SITE IS PERMANENTLY STABILIZED BY ESTABLISHED VEGETATION, FINISH LANDSCAPE MATERIALS, PAVED SURFACES, AND/OR ROOF AREA. REMOVE TRAPPED SEDIMENT AND DEBRIS FROM DETENTION / RETENTION BASIN BOTTOMS SO THAT FINISH BOTTOM MATERIALS / INFILTRATION FUNCTION CONFORM TO DESIGN.

3.07 LANDSCAPING

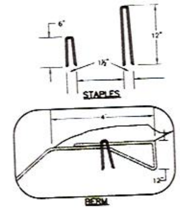
A. COMPLETE LANDSCAPING AS SOON AS POSSIBLE AFTER COMPLETION OF FINAL SUBGRADE.

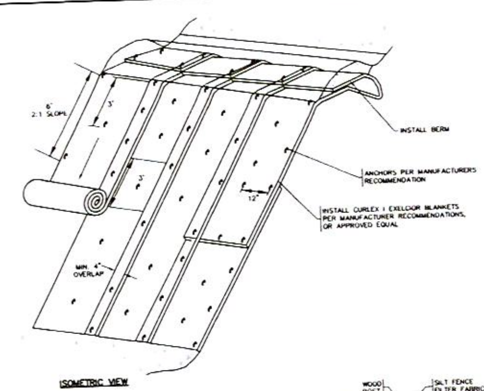
B. IMMEDIATELY AFTER PLACEMENT OF PERMANENT LOAM OR TOPSOIL TO FINISHED GRADE, PERMANENTLY STABILIZE WITH CONTROL MEASURES INCLUDING, BUT NOT NECESSARILY LIMITED TO, SEED MIX, MULCH, AND / OR EROSION CONTROL BLANKETS.



NOTES:
[1] SILT FENCE SHALL BE PLACED ALONG CONTOUR TO MAXIMIZE PONDING EFFICIENCY.
[2] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
[3] REMOVED SEDIMENT SHALL BE DEPOSITED TO A NON-SENSITIVE UPLAND AREA.

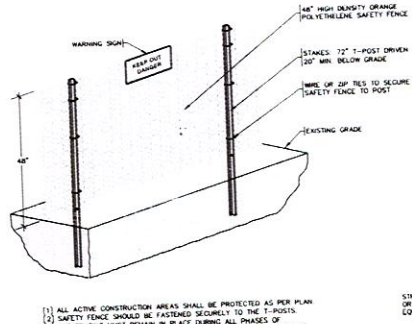
SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE





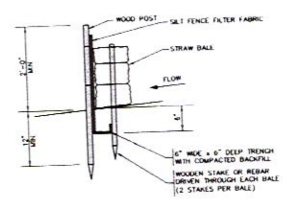
NOTES:
[1] SLOPE SURFACE SHALL BE FREE OF ROCK, CLODS, STICKS AND GRASS, MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT
[2] APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS
[3] LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH
[4] MATS/BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE
[5] TAMP SOIL OVER MAT/BLANKET

TURF REINFORCEMENT MAT
NOT TO SCALE



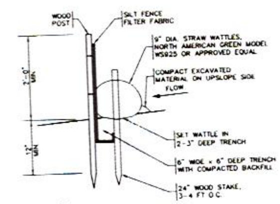
[1] ALL ACTIVE CONSTRUCTION AREAS SHALL BE PROTECTED AS PER PLAN.
[2] SAFETY FENCE SHOULD BE FASTENED SECURELY TO THE T-POSTS.
[3] THE FENCING MUST REMAIN IN PLACE DURING ALL PHASES OF CONSTRUCTION, ANY CHANGE OF THE PROTECTIVE FENCING MUST BE APPROVED.
[4] "DANGER KEEP OUT" SIGNS TO BE SPACED AT 100 FT INTERVALS

ORANGE CONSTRUCTION SAFETY FENCE
TYPICAL CROSS SECTION
NOT TO SCALE



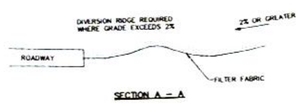
NOTES:
[1] BALES SHALL BUTT TOGETHER TO FORM A CONTINUOUS BARRIER.
[2] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
[3] TRAPPED SEDIMENT SHALL BE REMOVED TO A NON-SENSITIVE UPLAND AREA.

STRAW BALE / SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE

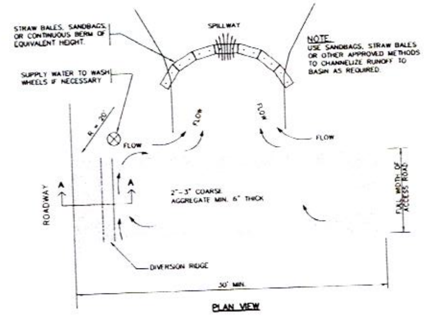


NOTES:
[1] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY
[2] TRAPPED SEDIMENT SHALL BE REMOVED TO A NON-SENSITIVE UPLAND AREA

STRAW WATTLE / SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE



SECTION A – A



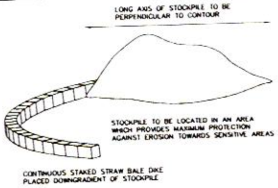
PLAN VIEW

NOTES:
1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.

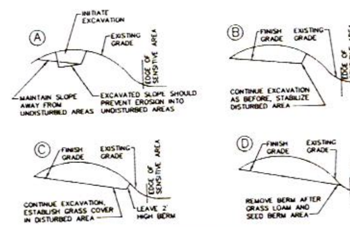
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.

3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

CONSTRUCTION ENTRANCE
NOT TO SCALE



TEMPORARY STOCKPILE
ISOMETRIC VIEW
NOT TO SCALE



EXCAVATION PROCEDURE
TYPICAL CROSS SECTION
NOT TO SCALE

DRAWING ISSUED FOR:

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COMMONWEALTH OF MASSACHUSETTS KYLE BURCHARD CIVIL ENGINEER NO. 54147 REGISTERED PROFESSIONAL ENGINEER

8/16/21

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION; LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES; DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE

NO.	DATE	BY	APP	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS

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SOLAR PHOTOVOLTAIC PROJECT

EROSION AND SEDIMENT CONTROL DETAILS

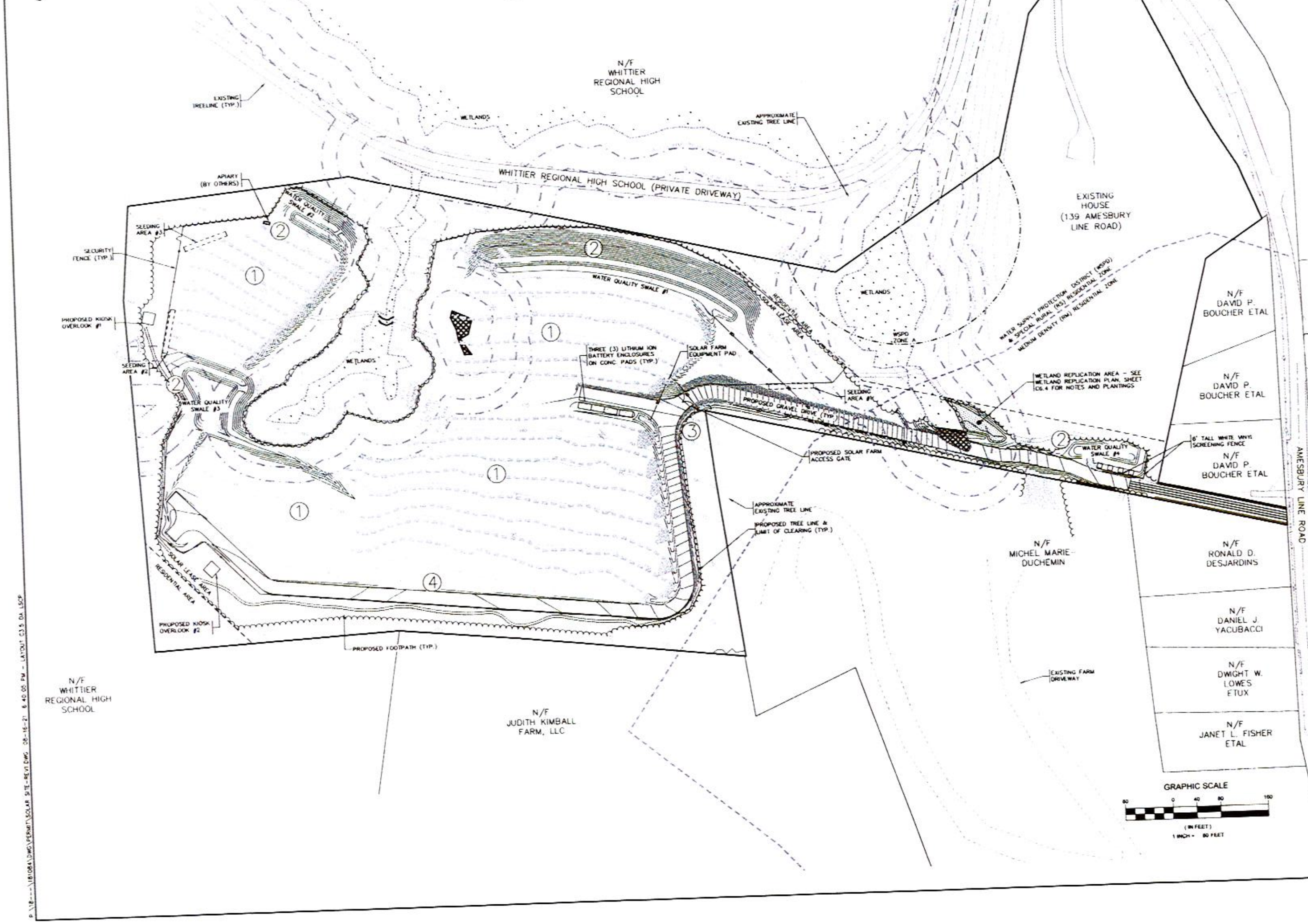
HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C3.4
CHK. BY: KFB			

LANDSCAPE NOTES

1. UNDER ALL SOLAR ARRAY PANELS: 4-INCH DEPTH LOAM SEED WITH NATIVE GRASSES PERENNIAL, SLOW GROWTH SOLAR MIX
2. AT ALL WATER QUALITY SWALE AREAS: 4-INCH DEPTH LOAM SEED WITH DROUGHT-TOLERANT NATIVE GRASSES/WILDFLOWER MIX
3. FIFTY (50) DECIDUOUS SLOW GROWTH TREES TO BE PLANTED WHERE POSSIBLE (DISTRIBUTED THROUGHOUT AND WITHIN SOLAR LEASE AREA)
4. AT ALL PERIPHERY AREAS INCLUDING EDGE OF DRIVEWAY AREAS: 4-INCH DEPTH LOAM SEED WITH DROUGHT-TOLERANT NATIVE GRASSES/WILDFLOWER MIX



LEGEND

EXISTING / PROPOSED

ELEVATION CONTOUR
SPOT GRADE
PROPERTY LINE
WETLAND DELINEATION
WETLAND BUFFER ZONE
SHORELINE
EPHEMERAL POOL DELINEATION
EPHEMERAL POOK BUFFER ZONE
100-YEAR FLOODPLAIN LIMIT
EDGE OF PAVEMENT
CAPE COD BERM CURBING
GRANITE CURBING
GRAVEL/DIRT ROAD
STOCKADE FENCE
STONE WALL
WATER MAIN
WATER SERVICE
FIRE SERVICE
WATER VALVE
FIRE HYDRANT
FORCE MAIN
GRAVITY SEWER LINE
SEWER MANHOLE
GAS LINE
GAS SERVICE
GAS VALVE
BURIED POWER LINE
OVERHEAD POWER LINE
UTILITY POLE
GUY WIRE
ELECTRIC BOX
STORM DRAIN
UNDERDRAIN
ROOF DRAIN
FOUNDATION DRAIN
CATCH BASIN
DRAIN MANHOLE
DEEP SOIL OBSERVATION HOLE
MAILBOX
SITE LUMINAIRE
SIGN
ELEVATION BENCHMARK
SURFACE RUNOFF DIRECTION
STONE BOUND
DRILL HOLE
IRON ROD

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

DRAWING ISSUED FOR:

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■ PERMIT ☐ CONSTRUCTION RECORD

COMMONWEALTH OF MASSACHUSETTS KYLE BURCHARD CIVIL ENGINEER NO. 54147 REGISTERED PROFESSIONAL ENGINEER

8/16/21

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SOLAR PHOTOVOLTAIC PROJECT

LANDSCAPING PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB | CHK. BY: KFB | DATE: APRIL 2021 | JOB 181084 | C3.5

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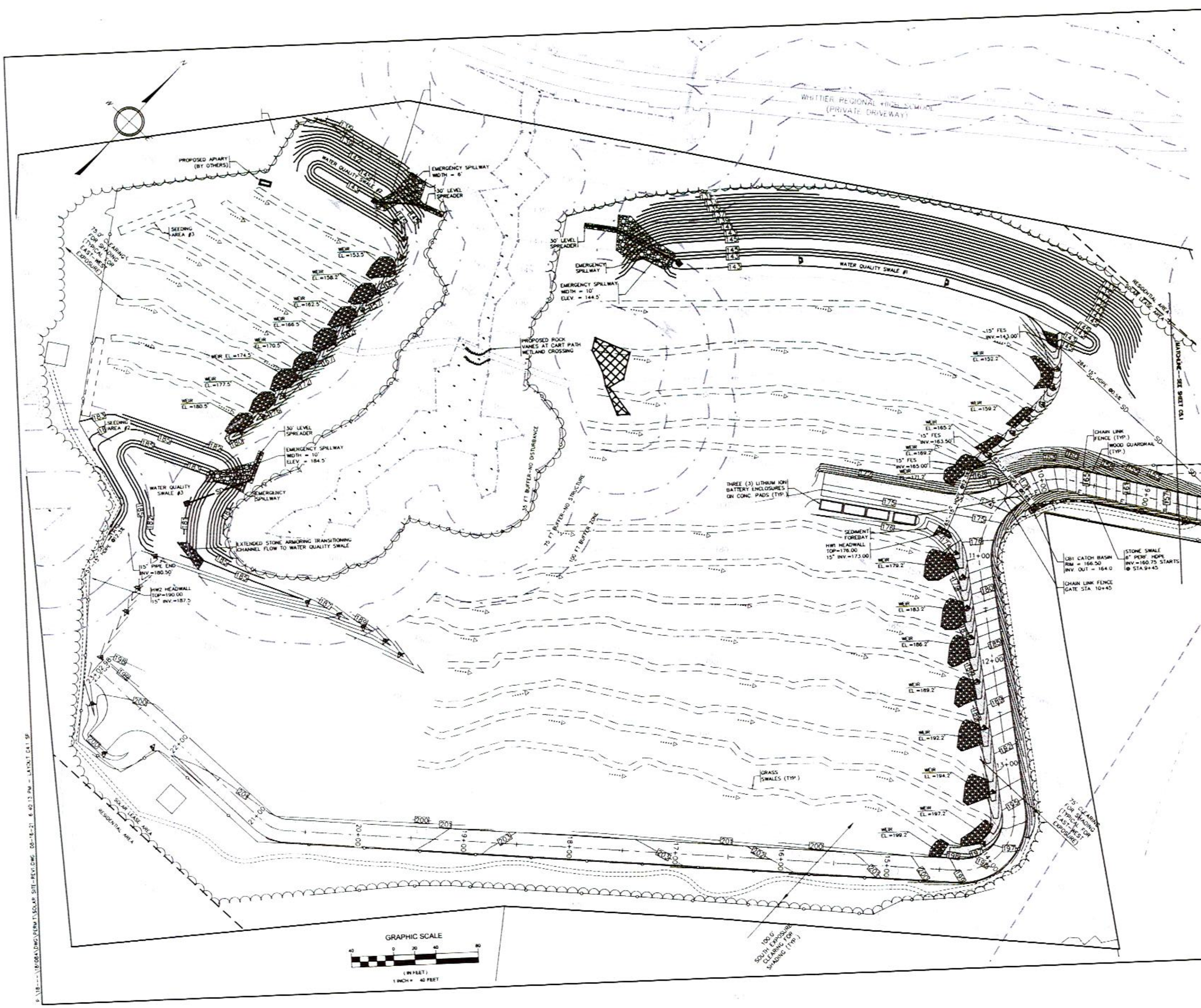

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COMMONWEALTH OF MASSACHUSETTS
KYLE BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED PROFESSIONAL ENGINEER

Kyle Burchard 8/16/21

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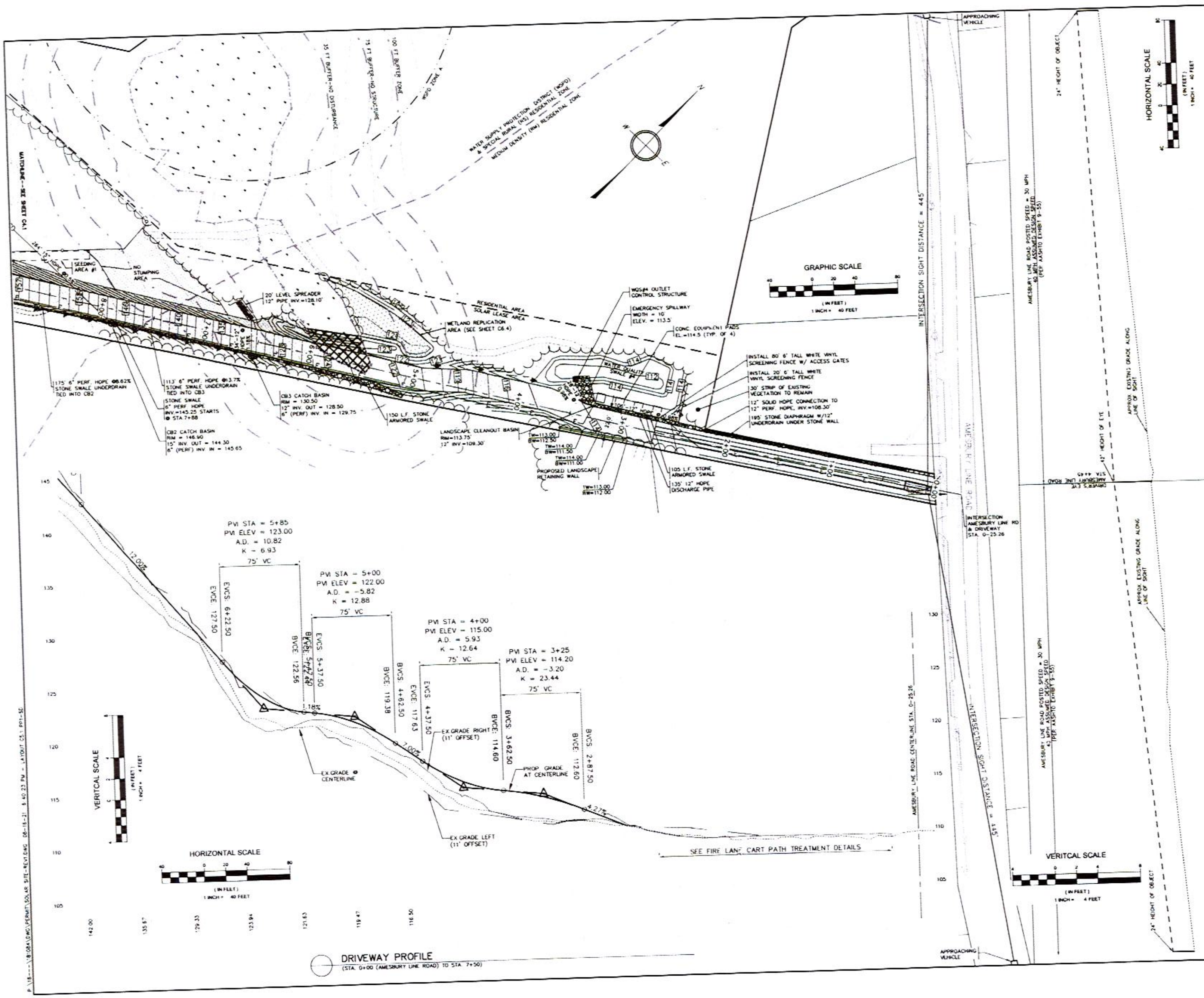
SOLAR PHOTOVOLTAIC PROJECT

SITE PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB CHK. BY: KFB	DATE: APRIL 2021	JOB 181084	C4.1



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SOLAR PHOTOVOLTAIC PROJECT

DRIVEWAY
PLAN & PROFILE
(STA. 0+00 TO 7+50)

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C5.1
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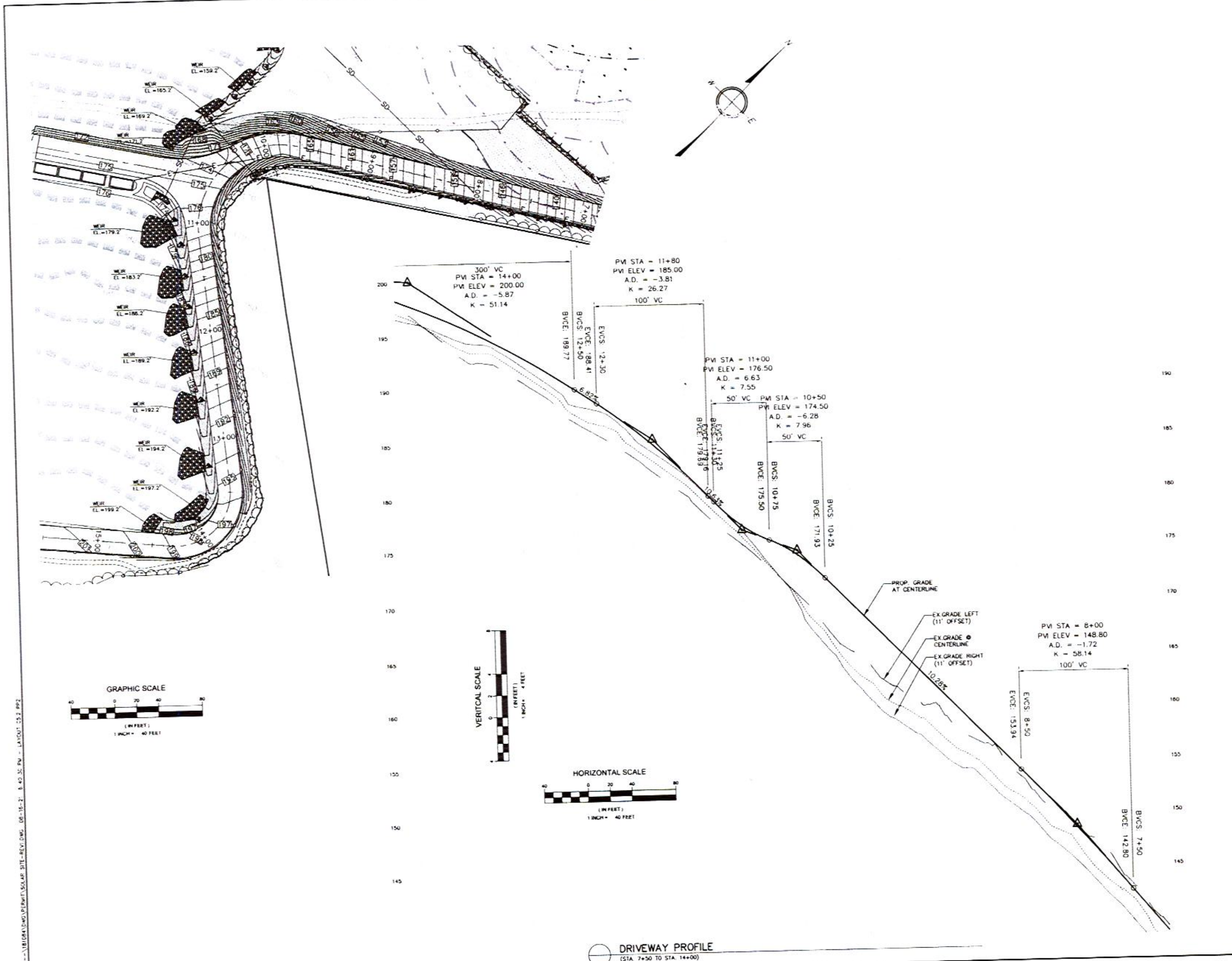

DRIVEWAY PROFILE
(STA. 7+50 TO STA. 14+00)

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8/16/21

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NO	DATE	BY	APP	REVISION DESCRIPTION
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SOLAR PHOTOVOLTAIC PROJECT

DRIVEWAY
PLAN & PROFILE
(STA. 7+50 TO 14+00)
HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
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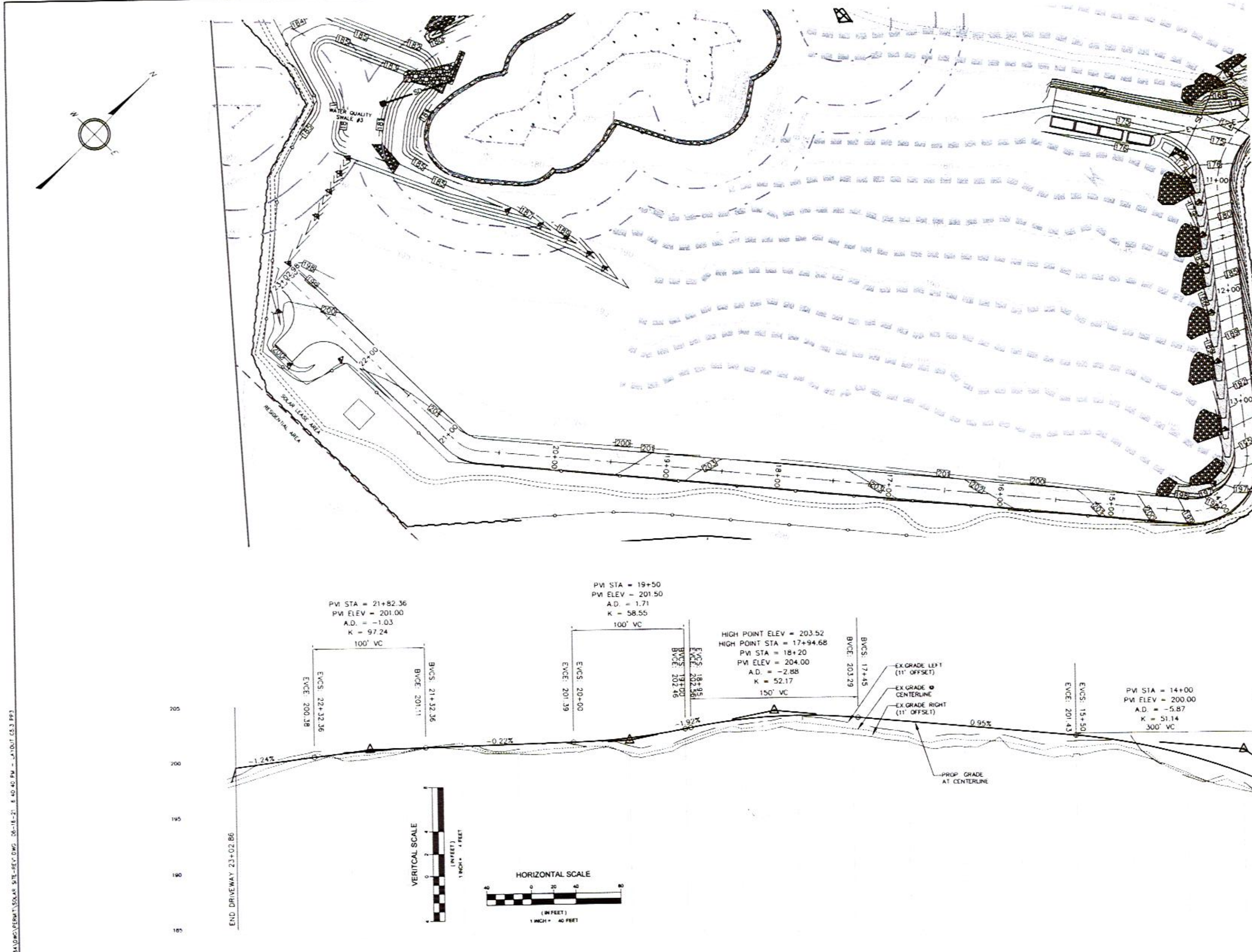
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE	APRIL 2021	JOB 181084	C5.2
CHK. BY: KFB				



DRIVEWAY PROFILE
(STA. 14+00 TO STA. 24+83)

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- ☐ CONSTRUCTION RECORD

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SOLAR PHOTOVOLTAIC PROJECT

DRIVEWAY
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139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
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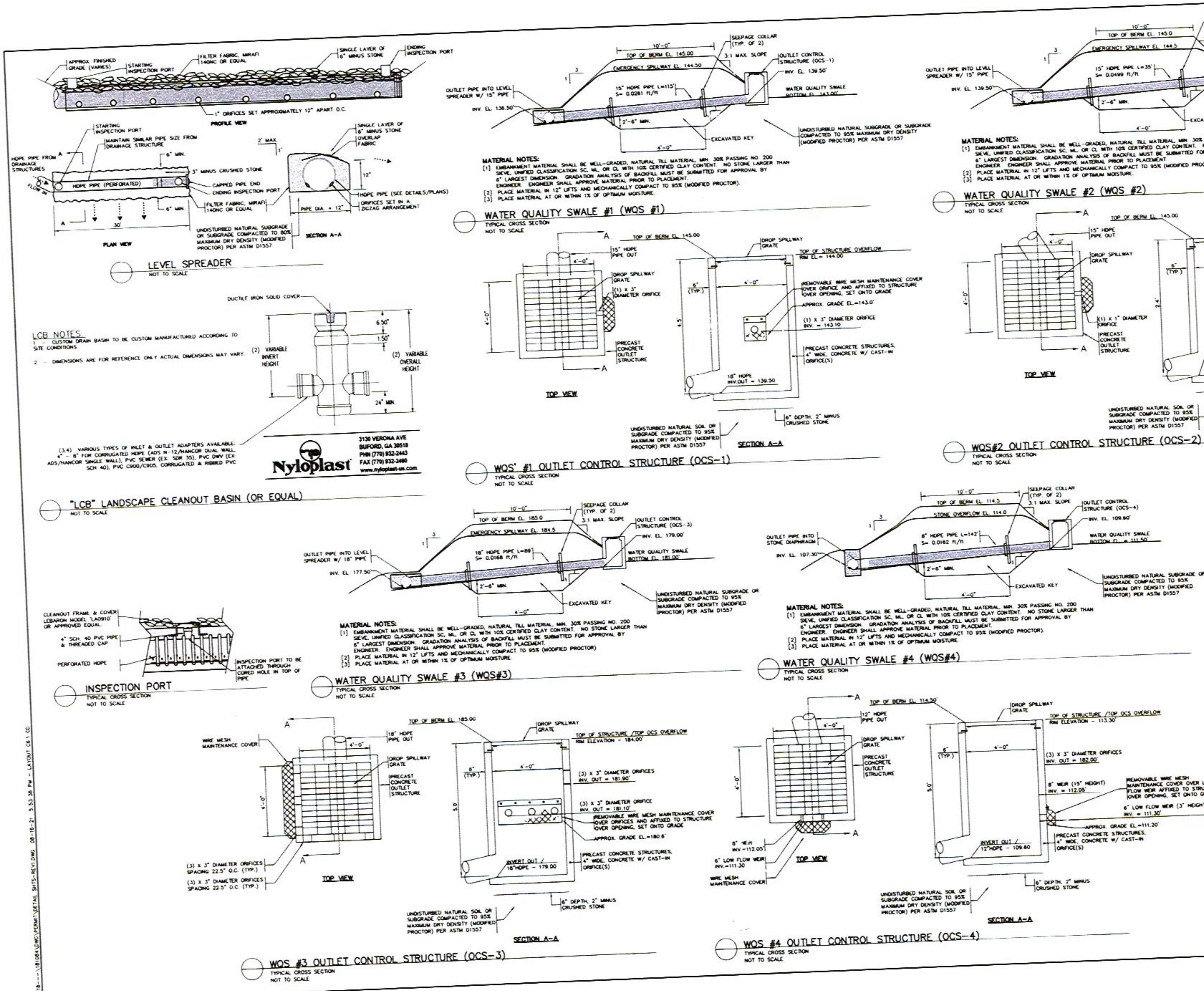

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KYLE BURCHARD CIVIL ENGINEER NO 54147 REGISTERED PROFESSIONAL ENGINEER COMMONWEALTH OF MASSACHUSETTS

8/16/21

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SOLAR PHOTOVOLTAIC PROJECT

CONSTRUCTION DETAILS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
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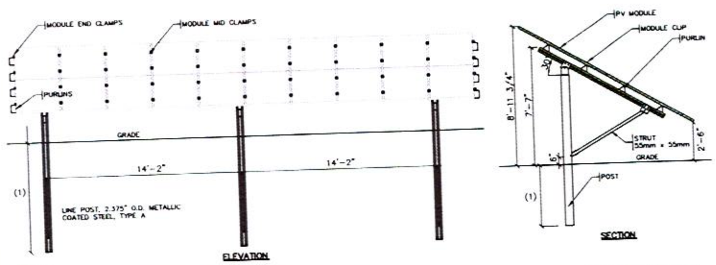
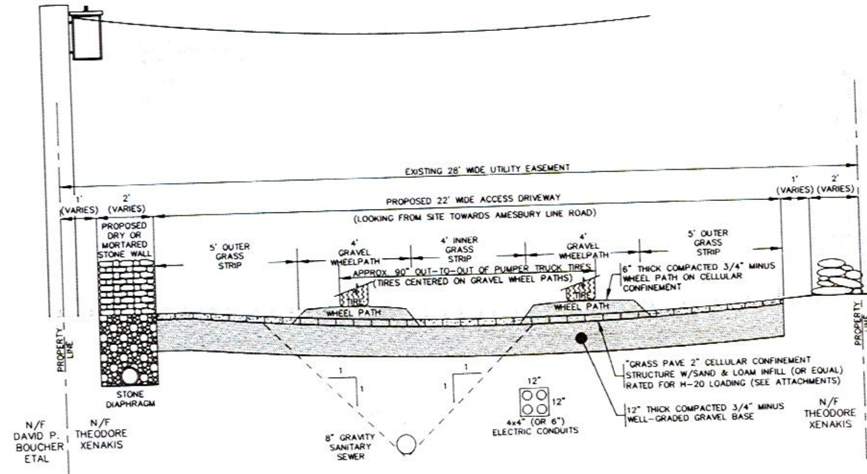
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB | CHK. BY: KFB | DATE: APRIL 2021 | JOB 181084 | C6.1



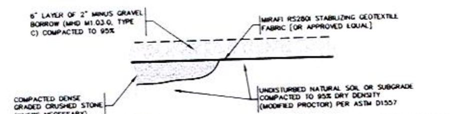
NOTES:
1. DRIVEN POST DEPTH TO BE DETERMINED IN FIELD GEOTECHNICAL ENGINEER
2. DIMENSIONS AND CONSTRUCTION MATERIALS SHOWN ARE PRELIMINARY IN NATURE AND SUBJECT TO CHANGE UPON COMPLETION OF THE FINAL ELECTRICAL DESIGN FOR THE DEVELOPMENT.
3. FINAL RACKING DETAILS AND DIMENSIONS BY OTHERS – CONTRACTOR TO VERIFY.

TYPICAL SOLAR FIELD ARRAY RACKING SYSTEM
TYPICAL CROSS SECTION
NOT TO SCALE



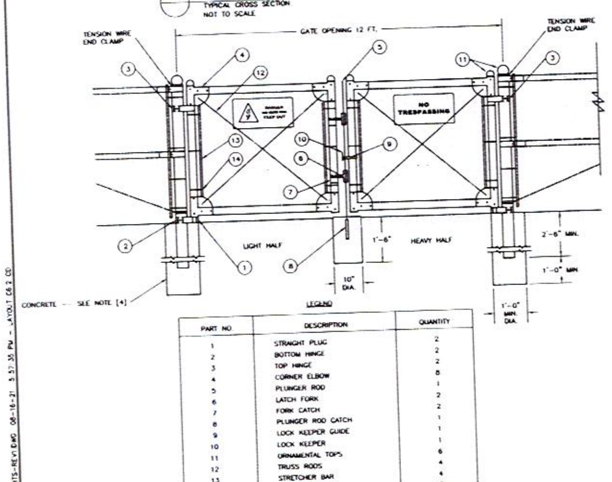
SITE ENTRANCE ACCESS DRIVE
TYPICAL CROSS SECTION
NOT TO SCALE

SIGNS – UNDERGROUND ELECTRIC WARNING SIGNS
TYPICAL CROSS SECTION
NOT TO SCALE



NOTES:
[1] UNSUITABLE MATERIAL IN THE SUBGRADE SHALL BE REMOVED AND REPLACED WITH AN ACCEPTABLE SUBSTITUTE MATERIAL. 3/4" MINUS DENSE GRADED CRUSHED STONE
[2] FINAL GRAVEL DRIVEWAY STABILIZATION DESIGN TO BE CONFIRMED BY THE GEOTECHNICAL ENGINEER.

GRAVEL DRIVEWAY/SHOULDER
TYPICAL CROSS SECTION
NOT TO SCALE

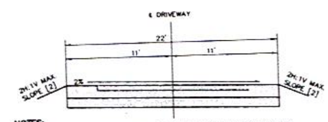


LEGEND

PART NO	DESCRIPTION	QUANTITY
1	STRAIGHT PLUG	2
2	BOTTOM HINGE	2
3	TOP HINGE	2
4	CORNER ELBOW	8
5	PLUNGER ROD	1
6	LATCH FORK	2
7	FORK CATCH	2
8	PLUNGER ROD CATCH	1
9	LOCK KEEPER GUIDE	1
10	LOCK KEEPER	1
11	ORNAMENTAL TOPS	6
12	TRUSS RODS	4
13	STRETCHER BAR	4
14	HOOK BOLTS	12

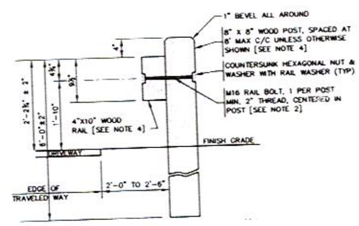
NOTES:
[1] ALL MATERIALS USED SHALL CONFORM TO AASHTO-M181.
[2] GATE POSTS SHALL BE 4" O.D. METALLIC COATED STEEL, TYPE A. EACH GATE SHALL BE FURNISHED WITH NECESSARY HINGES, LATCH AND DROP BAR LOCKING DEVICES.
[3] SIGNS MUST BE LOCATED AT EYE LEVEL AND LOCATED ON ALL GATES. DISTANCE BETWEEN SIGNS MUST NOT EXCEED 50'. AFFIX APPROPRIATE COMPANY OWNER NAME AND CONTACT INFO DECAL TO BOTH SIGNS.
[4] CONCRETE FOOTINGS SHALL BE AUGERED. ALL EXCAVATED MATERIALS FOR FOOTINGS INSIDE THE WETLAND BUFFER SHALL BE REMOVED FROM THE WETLAND BUFFER

CHAIN LINK FENCE GATE
TYPICAL CROSS SECTION
NOT TO SCALE



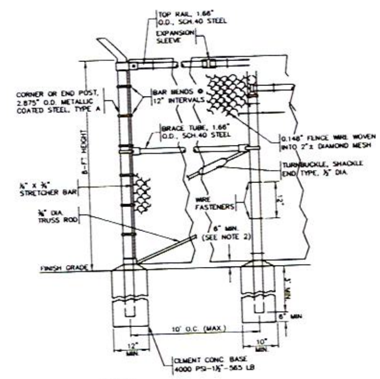
NOTES:
[1] DRIVEWAY AND SHOULDER CROSSLOPE IS UNIFORMLY TOWARDS NORTHERN SIDE OF DRIVEWAY AT 2%.
[2] SLOPE STABILIZATION REQUIRED WHEN > 3:1 SLOPE

GRAVEL DRIVEWAY SECTION–SHOULDERS ONLY
TYPICAL CROSS SECTION
NOT TO SCALE



NOTES:
[1] ALL NUTS, BOLTS & WASHERS ARE TO BE HIGH STRENGTH GALVANIZED STEEL
[2] ALL SPLICES ARE TO BE MADE AT POST; FOUR (4) BOLTS EACH SPLICE.
[3] BACK-UP PLATE IS TO BE PLACED BEHIND RAIL ELEMENTS AT NON SPLICE LOCATIONS (INTERMEDIATE POSTS).
[4] WOOD AND WOOD TREATMENT SHALL COMPLY WITH MASSACHUSETTS HIGHWAY DEPARTMENT SPECIFICATIONS AND STANDARDS.
[5] TERMINAL SECTIONS SHALL BE IN ACCORDANCE WITH MASSACHUSETTS HIGHWAY DEPARTMENT SPECIFICATIONS AND STANDARDS.

WOOD GUARDRAIL
TYPICAL CROSS SECTION
NOT TO SCALE



NOTES:
[1] ALL MATERIALS USED SHALL CONFORM TO AASHTO-M181.
[2] 6-INCH MIN & 9" MAX. CLEAR FROM BOTTOM OF CHAIN LINK FENCE TO FINISHED GRADE PER NHESP REQUIREMENTS.

CHAIN LINK FENCE
TYPICAL CROSS SECTION
NOT TO SCALE

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8/16/21

NO.	DATE	BY	APP.	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS

GPR
Engineering Solutions for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.
39 MAIN STREET, SUITE 301 AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978.772.1590 FAX: 978.772.1591
www.gpr-inc.com

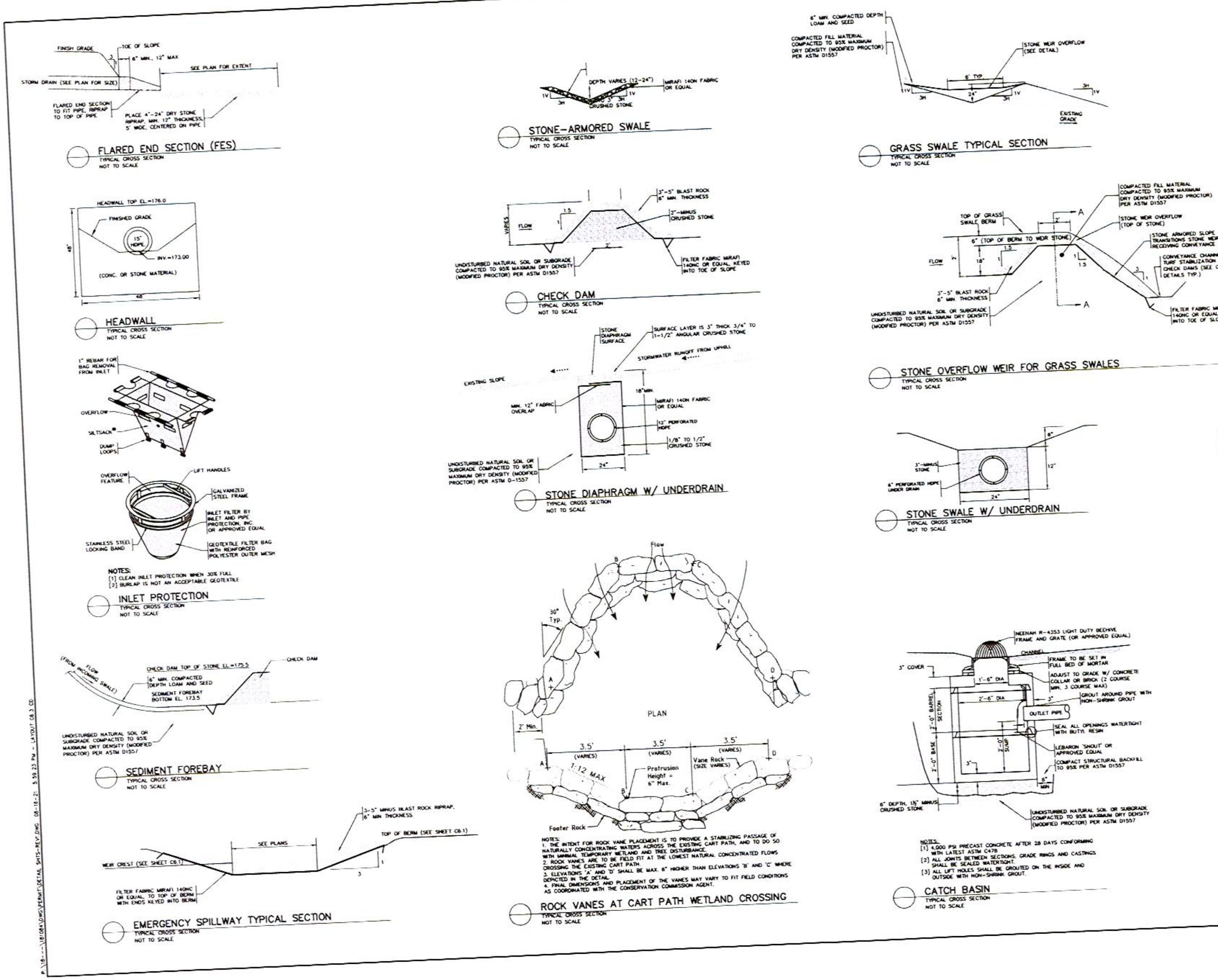
SOLAR PHOTOVOLTAIC PROJECT

CONSTRUCTION DETAILS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB
CHK. BY: KFB
DATE: APRIL 2021
JOB 181084
C6.2



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WETLAND REPLICATION PROCEDURE

PART 1 GENERAL

1.01 EXTENT OF WORK

A. THE WORK INCLUDES THE FURNISHING OF ALL PLANT, LABOR, EQUIPMENT, MATERIALS AND REQUIRED PROFESSIONAL SERVICES IN CONNECTION WITH THE PROTECTION, REPLICATION AND PROVISION OF SPECIFIC MITIGATION AND ENHANCEMENT MEASURES TO MINIMIZE AND COMPENSATE FOR IMPACTS TO WETLANDS.

B. IT SHALL BE THE RESPONSIBILITY OF THE APPLICANT TO RETAIN A BOTANIST, BIOLOGIST, WETLAND SCIENTIST OR OTHER INDIVIDUAL WITH QUALIFICATIONS AND A MINIMUM OF FIVE YEARS EXPERIENCE IN SIMILAR WETLAND REPLICATIONS, AND THOROUGHLY VERSED IN THE COMMONWEALTH OF MASSACHUSETTS WETLANDS PROTECTION ACT (MGL CHAPTER 131, SECTION 40) AND ALL OTHER RELEVANT REGULATIONS OF THE DEPARTMENT OF ENVIRONMENTAL PROTECTION. THIS INDIVIDUAL, HEREIN AFTER REFERRED TO AS "BOTANIST", SHALL BE APPROVED BY THE TOWN OF HAVERHILL CONSERVATION COMMISSION.

PART 2 EXECUTION

2.01 GENERAL

A. THE APPLICANT SHALL PLAN AND EXECUTE OPERATIONS IN A MANNER MINIMIZING THE AMOUNT OF EXCAVATED AND EXPOSED FILL, OR OTHER FOREIGN MATERIALS THAT MAY BE WASHED OR OTHERWISE CARRIED INTO THE REPLICATION AREAS.

2.02 EROSION/SEDIMENTATION CONTROL

A. THE APPLICANT SHALL INSTALL STRAW WATTLES AND/OR SILTATION FENCING AND UTILIZE EROSION/SEDIMENTATION CONTROL METHODS PRIOR TO THE COMMENCEMENT OF ANY WORK.

2.03 REPLICATION AREA PREPARATION

A. THE REPLICATION AREAS ARE TO BE CONSTRUCTED AFTER ALL CONTRIBUTING UPLAND DRAINAGE AREAS ARE BROUGHT UP FINISHED GRADE AND STABILIZED. THIS WETLAND REPLICATION SHALL BE PERFORMED UNDER THE DIRECTION AND GUIDANCE OF A QUALIFIED BOTANIST AND AS SPECIFIED HEREIN.

B. THE REPLICATION AREAS SHALL HAVE FINISHED GRADES WHICH MEET THE EXISTING GRADES IN THE ADJACENT WETLAND AS SHOWN ON THE GRADING PLAN.

C. BEFORE PLANTING THE REPLICATION AREAS, THE APPLICANT SHALL REMOVE ALL TREES, SHRUBS, STUMPS, AND SOD FROM THE REPLICATION AREAS. THESE ARE NOT TO BE STOCKPILED IN THE RESOURCE AREAS OR BUFFER ZONES WHILE AWAITING DISPOSITION.

D. DURING THE REMOVAL OF THE TREES, SHRUBS, STUMPS AND SOD, SOME OF THE SOILS (WITHIN THE REPLICATION AREAS) WILL LIKELY BE REMOVED DURING THE PROCESS. ADDITIONAL WETLAND SOILS SHALL BE PROVIDED IN QUANTITIES SUFFICIENT TO ESTABLISH GRADES AS SHOWN ON THE PREVIOUSLY REFERENCED PLANS. THE REPLACEMENT SOIL SHALL BE PURCHASED BY THE APPLICANT AT A 1:1 MIX OF LOAM TO PEAT.

1. THE REPLICATION AREAS SHALL BE EXCAVATED TO A DEPTH OF 8 TO 12 INCHES BELOW PROPOSED FINISH GRADES. THE REPLICATION AREAS ARE TO THEN BE BACKFILLED WITH A 1:1 MIXTURE OF LOAM TO PEAT.
2. THE WETLAND SOILS SHALL BE DEPOSITED IN THE REPLICATION AREAS IN A MANNER MINIMIZING TRAVEL AND SUBSEQUENT COMPACTION OF THE UNDERLYING MATERIAL AND REPLACEMENT WETLAND SOILS.
3. THE REPLICATION AREAS SHALL NOT HAVE FINISHED GRADING WHICH RESULTS IN A COMPLETELY FLAT TOPOGRAPHY. THE FINISH GRADING SHOULD RESULT IN A SHALLOW PIT AND MOUND TOPOGRAPHY THROUGHOUT THE REPLICATION AREAS.

E. ALL FILL MUST BE STOCKPILED WITH APPROPRIATE EROSION AND SEDIMENTATION CONTROLS. PRECAUTIONS SHALL BE TAKEN AS NECESSARY TO PREVENT EROSION OF THE STOCKPILED MATERIAL. BEFORE FILL IS PUT INTO PLACE, ALL TREES, BRUSH AND STUMPS SHALL BE REMOVED FROM THE AREAS TO BE FILLED.

F. THE FINISHED GRADES MUST BE WITHIN TWELVE INCHES FROM THE GROUNDWATER TABLE.

G. ANY SIGNIFICANT FIELD CHANGES DEEMED NECESSARY TO ACHIEVE FINAL GRADING WITHIN TWELVE INCHES FROM THE GROUNDWATER TABLE, MUST BE APPROVED BY THE BOTANIST (IN THE FIELD) AND REPORTED TO THE CONSERVATION COMMISSION IN THE WEEKLY REPORT.

H. THE OUTER EDGES OF THE REPLICATION AREAS SHALL BE BERMED TO PREVENT WATER DRAINING FROM THE REPLICATION AREAS.

I. UPON COMPLETION OF THE REPLICATION AREAS, SILTATION FENCE SHALL BE PLACED AROUND THE ENTIRE PERIMETER (OF THE REPLICATION AREAS) TO PROTECT THE REPLICATION AREAS DURING THE ESTABLISHMENT OF REPLICATION AREA GROWTH.

J. AFTER REPLICATION CONSTRUCTION IS COMPLETED, NO FERTILIZER, LIMESTONE, SUPERPHOSPHATE, MULCH OR OTHER AMENDMENTS SHALL BE ADDED TO THE WETLAND SOILS.

PART 3 REMOVING, STORING, AND REPLANTING OF EXISTING WETLAND SOIL, TREES AND SHRUBS

A. IN ANY FILLED WETLAND AREA (WHERE PRACTICAL), THE APPLICANT MAY, AT HIS OPTION, DIG UP, STORE AND MAINTAIN EXISTING WETLAND SOILS, TREES AND SHRUBS FOR USE IN THE REPLICATION AREAS. TREES SHALL BE A MINIMUM OF ONE INCH CALIPER AND SHRUBS SHALL BE THIRTY-SIX INCHES IN SPREAD OR HEIGHT. ALL PLANTS SHALL BE VIGOROUS AND WELL FORMED SPECIMENS. ALL PLANT MATERIALS DUG FOR THIS PURPOSE SHALL BE DUG BY HAND, HYDRAULIC TREE SPADE SPECIFICALLY DESIGNED FOR THIS PURPOSE OR OTHER SUITABLE EQUIPMENT OF SUFFICIENT SIZE TO REMOVE THE ROOTBALL. ROOTBALL SIZE SHALL BE THE MINIMUM SPECIFIED BY THE AMERICAN ASSOCIATION OF NURSERYMEN FOR EACH SPECIES. FOR HAND DUG PLANTS, A SUITABLE BURLAP OR OTHER WRAP OR CONTAINER SHALL BE PROVIDED TO KEEP THE ROOTBALL INTACT.

1. ALL PLANTS DUG FOR REUSE SHALL BE IMMEDIATELY MOVED TO A PROTECTIVE STORAGE AREA APPROVED BY THE BOTANIST. PLANTS SHALL BE SET PLUMB ON GRADE OR IN PREPARED HOLES AND GUYED AS NECESSARY. THE AREA OR HOLES SHALL BE BACKFILLED WITH SUITABLE TOPSOIL TO COVER THE ROOTBALLS ENTIRELY MULCHED TO PREVENT EROSION. ALL STORED VEGETATION SHALL BE MAINTAINED IN A DAMP CONDITION BY REGULAR WATERING. ALL HORTICULTURAL MEASURES REQUIRED FOR THE SURVIVAL OF COLLECTED PLANTINGS SHALL BE UTILIZED BY THE APPLICANT.
2. AFTER THE REPLICATION AREAS HAVE BEEN CONSTRUCTED, STOCKPILED PLANTS SHALL BE REPLANTED IN LOCATIONS SPECIFIED AND APPROVED BY THE BOTANIST.

PART 4 WETLAND REPLICATION PLANTING

A. WETLAND PLANTING SHALL BE PERFORMED BETWEEN MARCH 1 AND OCTOBER 15 OR AS RECOMMENDED BY THE BOTANIST.

B. WETLAND PLANTINGS SHALL CONSIST OF A MINIMUM OF 8 TREES PLANTED NO FARTHER APART THAN FIFTEEN FEET ON CENTER AND A MINIMUM OF SIXTEEN (16) SHRUBS PLANTED NO FARTHER APART THAN TEN FEET ON CENTER.

1. THE TREE LAYER WILL BE COMPRISED OF EIGHT (8) RED MAPLES (ACER RUBRUM).
2. SHRUBS SHALL CONSIST OF SIXTEEN (16) WINTERBERRY (ILEX VERTICILLATA).
3. HERBACIOUS PLANTS SHALL BE COMPRISED OF TWENTY FIVE (25) SENSITIVE FERNS (ONOCLEA SENSIBILIS).

C. THE APPLICANT SHALL HAVE THE OPTION OF DIGGING, STORING AND REPLANTING EXISTING TREES AND SHRUBS PER PART 3 OF THIS SCHEDULE, OR ALTERNATIVELY, PROVIDING AND PLANTING NEW WETLAND SPECIES, PURCHASED BY THE APPLICANT FROM NURSERY STOCK, AND APPROVED BY THE BOTANIST.

D. WETLAND PLANTING, IN THE REPLICATION AREAS, SHALL BE PERFORMED IN A MANNER WHICH REPRODUCES THE PLACEMENT AND PROPORTIONS OF THE PLANT SPECIES THAT WERE FOUND IN THE ORIGINAL LOST WETLAND AREAS.

E. ALL WETLAND PLANTINGS SHALL BE PERFORMED BY HAND. BURLAP SHALL BE REMOVED FROM THE TOP THIRD OF THE ROOTBALLS AND ROPES, TWINE AND WIRE BASKETS SHALL BE COMPLETELY REMOVED FROM THE ROOTBALLS. COMPLETELY REMOVE ALL PLASTIC BURLAP, ROPE, TWINE AND WIRE BASKETS FROM THE REPLICATION AREAS. COMPLETELY REMOVE THE CONTAINERS FROM THE POTTED PLANTS WHILE KEEPING THE SOIL AROUND THE ROOTS UNBROKEN.

F. AFTER PLANTINGS ARE COMPLETED, THE REPLICATION AREAS SHALL BE HAND RAKED TO ELIMINATE ANY DEPRESSIONS, GREATER THAN FOUR INCHES IN DEPTH, WHICH MAY BE CREATED DURING DIGGING AND TO ELIMINATE COMPACTION OF THE SOILS AS MUCH AS POSSIBLE.

1. ONCE PLANTING IS COMPLETED, LEAVES (COLLECTED FROM UPLAND AREAS OF THE PROPOSED SITE CONSTRUCTION) SHALL BE SPREAD THROUGHOUT THE REPLICATION AREAS.

G. THE INTENT OF THIS SCHEDULE IS TO INSURE THAT AT LEAST 75 PERCENT OF THE REPLICATION SURFACE AREA IS RE-ESTABLISHED WITH INDIGENOUS WETLAND PLANT SPECIES WITHIN TWO GROWING SEASONS OF THEIR PLANTING, IN ACCORDANCE WITH THE MASSACHUSETTS DEP WETLANDS PROTECTION ACT REGULATIONS. PURPLE LOOSESTRIFE (LYTHRUM SALICARI) AND EUROPEAN BUCKTHORN (RHAMNUS FRANGULA) SHALL NOT BE PLANTED IN THE REPLICATION AREAS. IF AFTER 180 GROWING SEASON DAYS, IT IS EVIDENT IN THE OPINION OF THE BOTANIST THAT IT IS UNLIKELY THAT THE 75 PERCENT RE-ESTABLISHMENT REQUIREMENT WILL BE ACHIEVED, THE APPLICANT SHALL SUPPLEMENT THE PLANTINGS AS NECESSARY TO ACHIEVE THE REQUIRED COVERAGE. IF AFTER THE END OF TWO GROWING SEASONS, 75 PERCENT RE-ESTABLISHMENT HAS NOT BEEN ACHIEVED, THE APPLICANT SHALL PROVIDE AND PLANT HEALTHY WETLAND VEGETATION IN SUFFICIENT QUANTITIES TO ACHIEVE THE 75 PERCENT RE-ESTABLISHMENT.

PART 5 WETLAND REPLICATION MONITORING

A. THE CITY OF HAVERHILL CONSERVATION COMMISSION SHALL BE NOTIFIED 72 HOURS IN ADVANCE OF THE COMMENCEMENT OF THE WETLAND REPLICATION CONSTRUCTION.

B. ALL CONSTRUCTION AND PLANTING SHALL BE OVERSEEN BY A QUALIFIED BOTANIST. (THE REPLICATION SHALL BE OVERSEEN BY A QUALIFIED PERSON, APPROVED IN ADVANCE BY THE COMMISSION. UPON COMPLETION OF THE REPLICATION, THE QUALIFIED PERSON SHALL SUBMIT A REPORT TO THE COMMISSION DOCUMENTING THE SPECIES OF THE PLANTINGS AND GENERALLY, SOIL CONDITIONS AND HYDROLOGY IN THE AREA.)

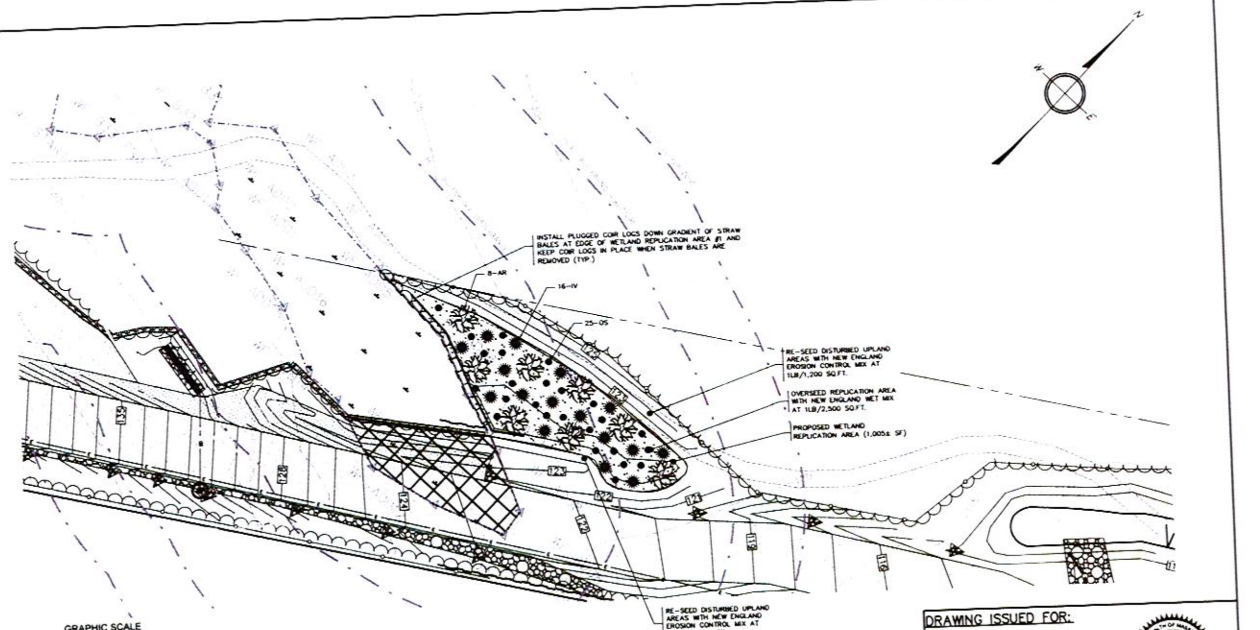
C. A BRIEF PROGRESS REPORT WILL BE PROVIDED TO THE TOWN OF AYER CONSERVATION COMMISSION AT THE END OF EACH WEEK UNTIL CONSTRUCTION AND PLANTING OF THE REPLICATION AREAS HAVE BEEN COMPLETED. (THE REPORT SHALL INCLUDE THE SPECIES OF PLANTS IN THE REPLICATION AREAS, RELATIVE NUMBER OF EACH SPECIES, PERCENT COVERAGE, BROKEN DOWN BY UPLAND AND WETLAND SPECIES, THE VIABILITY OF THE SPECIES PRESENT IN THE AREA AND RECOMMENDED REMEDIAL ACTIONS NECESSARY TO ACHIEVE 75% COVERAGE WITH WETLAND SPECIES PLANTS.)

D. FOUR REPORTS, PREPARED BY A QUALIFIED BOTANIST, SHALL BE SUBMITTED TO THE CITY OF HAVERHILL CONSERVATION DURING THE FIRST YEAR. THESE REPORTS WILL BE SUBMITTED QUARTERLY. TWO REPORTS WILL BE PROVIDED TO THE TOWN OF AYER CONSERVATION COMMISSION ON MAY 1ST AND OCTOBER 1ST OF THE FOLLOWING YEAR.

E. EACH REPORT SHALL INCLUDE AN OBSERVED SPECIES LIST, RELATIVE ABUNDANCE OF EACH SPECIES, PERCENT COVER OF UPLAND AND WETLAND SPECIES, THE VIABILITY OF THE PLANTINGS AND PROPOSED REMEDIAL MEASURES TO ENSURE 75 PERCENT RE-ESTABLISHMENT WITHIN TWO GROWING SEASONS.

F. WHILE PERFORMING THE INSPECTION OF THE REPLICATION AREAS, ANY INVASIVE PLANTS SPECIES FOUND SHALL BE REMOVED. THE PLANT SPECIES, AND NUMBER OF PLANTS REMOVED, SHALL BE INCLUDED WITHIN THE MONITORING REPORTS.

G. IF THE REPLICATION AREAS DO NOT ACHIEVE THE REQUIRED 75 PERCENT COVERAGE WITHIN TWO GROWING SEASONS, THEN ADDITIONAL PLANTINGS SHALL BE PROVIDED AS PER PART 4 SECTION G. THESE PLANTINGS WILL BE MONITORED FOR THE NEXT TWO GROWING SEASONS WITH REPORTS PROVIDED TO THE CITY OF HAVERHILL CONSERVATION COMMISSION ON MAY 1ST AND OCTOBER 1ST OF EACH YEAR IN ORDER TO ENSURE THE VIABILITY OF THESE LATE PLANTINGS.



GRAPHIC SCALE

20 0 10 20 40

(IN FEET)
1 INCH = 20 FEET

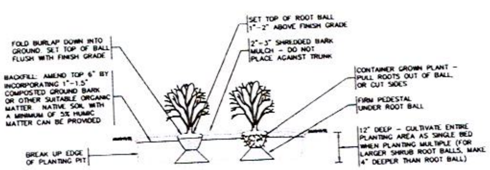
WETLAND REPLICATION AREA
SCALE: 1" = 20'

ADDITIONAL WETLAND REPLICATION NOTES:

EXISTING SPECIES OBSERVED IN THE WETLANDS BEING DISTURBED CONSIST LARGELY OF WINTERBERRY AND ALDERS, AS WELL AS CATTAILS. THE EXISTING SOILS ARE ENTIRELY FREETOWN MUCK.

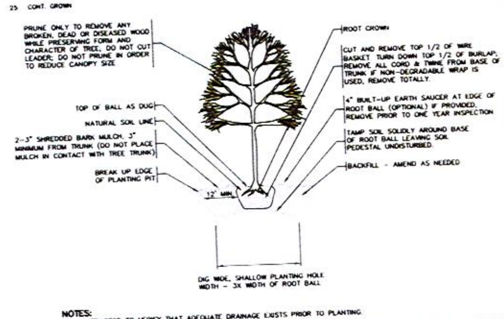
PLANT LIST

	Symbol	Botanical Name	Common Name	Size	Quantity	Condition
TREES	AR	ACER RUBRUM	RED MAPLE	6'-8' HT. 1.5'-2' CAL	8	B & B
SHRUBS	IV	ILEX VERTICILLATA	WINTERBERRY	2'-3' HT.	16	CONT. GROWN
HERBACIOUS PLANTS	OS	ONOCLEA SENSIBILIS	SENSITIVE FERN	#1 POT	25	CONT. GROWN



NOTES:
1. ALL SHRUBS MUST CONFORM TO THE STANDARDS SET FORTH IN THE MOST RECENT AMERICAN STANDARDS FOR NURSERY STOCK, PUBLISHED BY THE AMERICAN ASSOCIATION OF NURSERYMEN (A.A.N.)
2. SOIL ANALYSIS SHALL BE OBTAINED PRIOR TO PLANTING. SOIL SHALL BE AMENDED AS RECOMMENDED.
3. SHEET PREPARATION OF BEDS IS HIGHLY PREFERRED TO INDIVIDUALLY DUG HOLES.

SHRUB PLANTING
NOT TO SCALE



NOTES:
1. CONTRACTOR TO VERIFY THAT ADEQUATE DRAINAGE EXISTS PRIOR TO PLANTING.
2. DO NOT WRAP TRUNK OF TREE.
3. STAKING OF TREES IS NOT RECOMMENDED, EXCEPT ON WINDY SITES OR FOR LARGE EVERGREEN TREES. IF STAKING IS DONE, FLEXIBLE STRAPS - NOT HOSE AND WIRE - SHOULD BE USED AND MUST BE REMOVED AT APPROPRIATE TIME.
4. ALL TREES SHALL CONFORM TO THE STANDARDS SET FORTH IN THE MOST RECENT AMERICAN STANDARDS FOR NURSERY STOCK PUBLISHED BY THE AMERICAN ASSOCIATION OF NURSERYMEN (A.A.N.)
5. TREES WITH ROOT FLARE COVERED BY MORE THAN 1.5" OF SOIL WILL BE REJECTED PRIOR TO INSTALLATION.

TREE PLANTING
NOT TO SCALE

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COMMONWEALTH OF MASSACHUSETTS KYLE BURCHARD CIVIL ENGINEER NO 54147 REGISTERED PROFESSIONAL ENGINEER

8/16/21

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SOLAR PHOTOVOLTAIC PROJECT

WETLAND REPLICATION PLAN

HAVERHILL SOLAR
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HAVERHILL, MA

PREPARED FOR:
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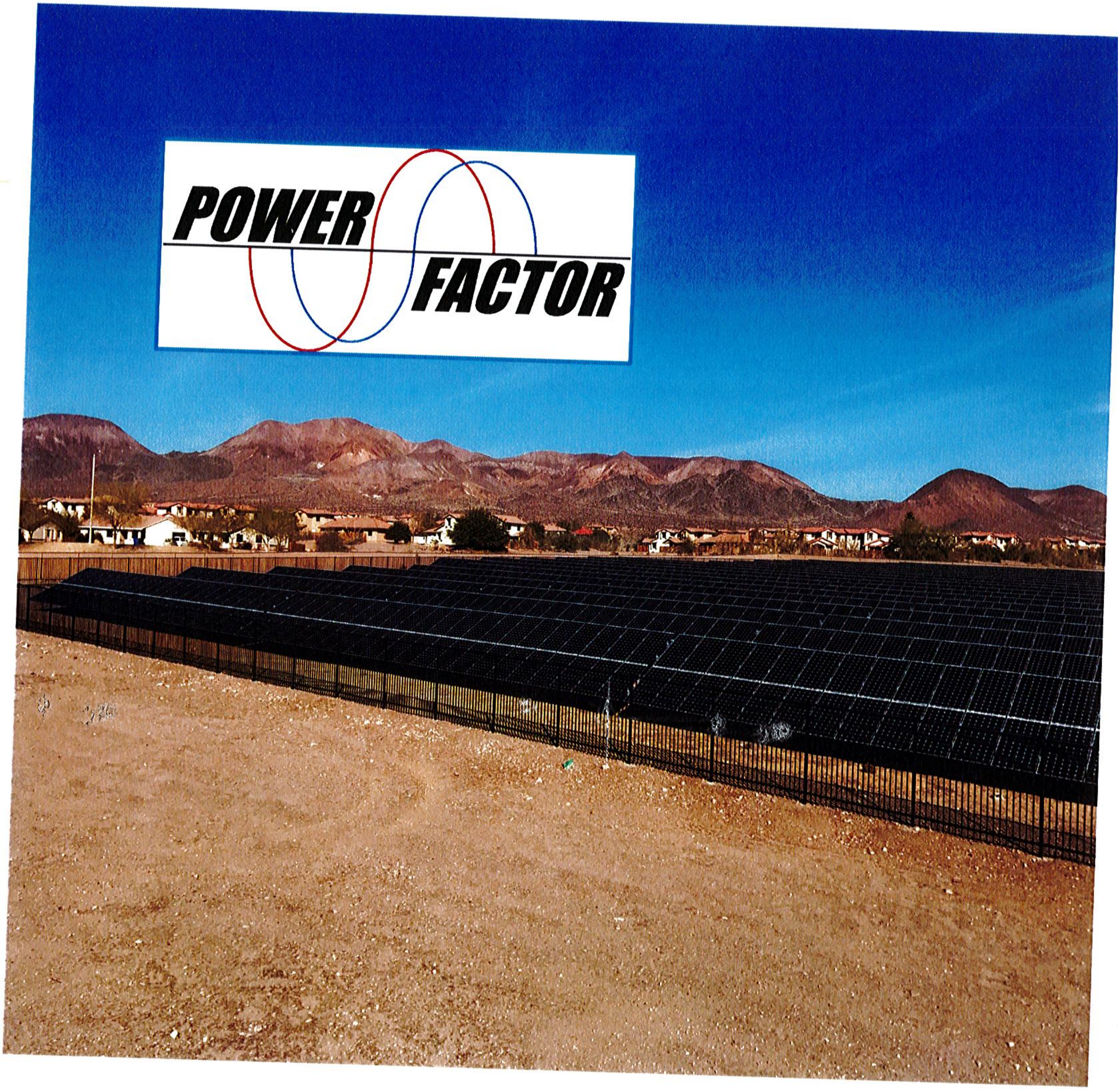


O&M PROPOSAL

George Lang IV
Andrew@powerfactorco.com

O&M Proposal

POWER FACTOR

Part 1: Bidder Contact Information

Bidder Contact Information
Corporate Name: Power Factor, LLC
Corporate Address: 8240 Beachwood road, Dundalk MD 21222
Parent's Corporate Name: Power Factor LLC
Parent's Corporate Address: 8240 Beachwood road, Dundalk MD 21222
Legally Authorized Representative
Name: George Lang
Title: Managing Director
Phone: (443) 827 7543
Fax:
E-mail: george@powerfactorco.com
Signature:
Primary Contact:
Name: Andrew Streit
Title: Director of Business Development
Phone: (803) 665-6688
Fax:
E-mail: andrew@powerfactorco.com
Signature:

Part 2: Executive Summary

Power Factor is honored to submit our qualifications for solar photovoltaic operations and maintenance services to Amesbury Line Solar LLC. Our company is ideally situated to deliver professionalism, excellence, efficiency and durability to Amesbury Line Solar in its efforts to successfully deploy solar projects on its properties. Due to a decade of involvement in developing customized renewable energy projects for public and private clients, Power Factor has an intimate understanding of the energy market in the southeastern United States. Our previous work with public entities has demonstrated that an elevated level of execution and delivery are the minimum standard for every government contract. We are prepared to meet and exceed those standards.

- Power Factor brings with it an experienced team of solar professionals that have successfully completed a large portfolio of projects ranging from rooftop solar arrays to solar parking canopies to utility scale solar farms.
- Power Factor has successfully deployed solar systems for a number of public entities, including various military and municipal installations.
- Power Factor has worked hand-in-hand with utilities, electric cooperatives, regulators, and private and public-sector entities to find economic, clean energy solutions that satisfy the aesthetic and sustainability goals of the client.
- Power Factor has amassed the professional capacity to manage projects on time and on budget even in the midst of challenging circumstances.
- Power Factor's reputation and history of successful solar project management should provide Amesbury Line Solar with the confidence it needs when selecting an experienced, knowledgeable operations and maintenance firm for this project.

Sustainability is not a catch phrase. It is the foundation of successful organizations. Power Factor recognizes that inventing and deploying the nation's utility grid was the single most important investment of the 20th century. Improving efficiency and eliminating waste will be primary drivers for the public and private sectors during the years to come. Given Power Factor's expertise and passion for the advancement of solar as a mainstream component of our country's energy portfolio, we are well prepared to lead in the realization and execution of these maintenance agreements. We are confident that our services will bring with them maximum value to Amesbury Line Solar and will result in a durable sustainability commitment. Power Factor is genuinely excited about our potential role in this process. We are proposing to provide all the preventative and corrective maintenance options requested, as well as providing training of any interested on-site personnel.

O&M Proposal

Preventive Maintenance Requirements and Costs
List of services:

Standard

Preventative Maintenance Work Scope	
Array Balance System	**Yes/No**
Array visual inspection-wire management, connector tightness, and insulation inspection	Yes
Array ground/racking debris removal and vegetation inspection	Yes
Verify fence condition and grounding	Yes
Inspect system and site drainage	Yes
Module Visual Inspection	**Yes/No**
Inspect 100% of glass side for cleanliness and obvious defects	Yes
Inspect 100% of back-sheet a J-Boxes	Yes
Inspect 100% of module clamps for looseness	Yes
String Inverters (Central Inverters vary by Size/Band)	**Yes/No**
Inspect for corrosion, labelling and basic condition of housing	Yes
Verify functionality of display and operation of PV system	Yes
Inspect base of inverter and conduit entry points	Yes
Clean inverter interior and inspect for moisture intrusion	Yes
Check string fuse functionality	Yes
Check ground straps and ensure all grounds are intact and tight to the enclosure	Yes
Clean heat sink and filters (replace filters if necessary)	Yes
Torque AC and DC conductors connections to manufacturers specs	Yes
IR scan all string terminations	Yes
AC/DC Disconnections & Panel Boards	**Yes/No**
Cycle all movable parts in AC/DC disconnect & Panel Boards	Yes
Torque all conductor connections to manufacturers specs	Yes
IR scan all string terminations	Yes
DAS & MET Stations	**Yes/No**
Inspect cabinet for labelling, corrosion, moisture intrusion and basic conditions of housing	Yes
Ensure all conductors and wires are routed in a neat and clean manner	Yes
Torque data terminations to manufacturers specs	Yes
Clean reference cell and/or pyranometer (Replace desiccant)	Yes
Verify functionality of all DAS Components	Yes
Other Services (Please list below)	**Yes/No**

Corrective Maintenance Requirements and Costs

Corrective Maintenance (CM) Services are generally triggered by a monitoring alert reporting an issue at the site. Certain alerts can be corrected remotely, while more severe alerts can require an emergency response due to safety concerns, or (far more typically) permit the on-site service call to be scheduled.

Please indicate which services your company provides and the respective costs associated with typical corrective maintenance service visit in the O&M bid below. The preferred cost structure can be in terms of Hourly, Half Day, or Full Day Rate.

Standard

Corrective Maintenance Work Scope	
Common Corrective Maintenance Task	**Yes/No**
Inverter troubleshooting and warranty management	Yes
String and Connector repairs	Yes
Panel Replacements	Yes
Panel manufacturer defect identification and tracking	Yes
Monitoring troubleshooting and repair	Yes
Fuse replacements	Yes
Breaker tightening and replacement	Yes
Transformer Oil Sampling	Yes
Ground fault identification	Yes
System wide IV Curve testing	Yes
Aerial or customized IR thermal imaging	Yes
Power Quality Analysis	Yes
Additional Services May Include	**Yes/No**
Auditing/correcting sites installed by others	Yes
Commissioning of sites installed by others	Yes
Medium Voltage and Fiber Optic Services	Yes
Other Services (Please list below)	**Yes/No**

Cost Structure for Above Indicated Services (Fill in all that apply)	
Hourly Rate	$75/hr
Half Day Rate	$250
Full Day Rate	$500

Typical Rate Sheet for Additional Services

O&M Proposal

POWER FACTOR

Service Levels and Rates		
Service	**Description**	**Rate**
Medium Voltage Electrician	Electrical fault repair, upgrades and modifications, field engineering, transformer testing, underground fault location, site management	$100/hr
Master Electrician	Electrical fault repair, upgrades and modifications, field engineering, transformer testing, underground fault location, site management	$75/hr
Level 3 Datacom Electrician	Advanced Datacom troubleshooting, fiber repair, level 1 and 2 capable	$50/hr
Level 2 Technician	Inverter and Datacom second level troubleshooting, panel testing, fuse and cable replacement. Captures IV Curves, IR Images and Power Quality measurements. OEM repairs	$36/hr
Level 1 Technician	Inverter and Datacom resets. Primary troubleshooting, records site data and fault codes. Replaces solar panels, was panels, and completes basic electrical and mechanical repairs	$25/hr
Professional Services	Performance engineering, integration services, system designs, commissioning review, project management and services oversight	$47/hr
Travel Charges	For teams of 2: Labor + Mileage	
Per Diem	For teams of 2: Overnight Accommodations	$250
Overtime	Workdays exceeding 8 hours	
Emergency Response	Deploy within 4 hours of notification	

Specialized Site Services		
Service	**Description**	**Rate**
Transformer Service	Sample of transformer fluid for DGA, refill nitrogen, includes all labor, laboratory and material costs	
Technical Services	Underground Fault Location (UFL), Infra-Red Imaging Diagnostics (IR Imaging), Module and String level I-V Characterization (IV Curves), DC/AC Power Quality Analysis (PQA)	

Other Services (Please list below)		
Service	**Description**	**Rate**

Onsite training for Amesbury Line Solar

Power Factor is happy to offer Amesbury Line Solar training services.

Training Services and Rates		
Training	**Description**	**Rate**
1-Day Training	Training to be held for Points of Contacts at a location provided by AMESBURY LINE SOLAR	$25/hr
Customize in-class training	Half Day training(s) on specific topics of need for AMESBURY LINE SOLAR	$50/hr
Field Shadowing	On-site, hands-on training	$25/hr
Not Applicable	Our company does not provide specific training	

Credibility

References:

- Maryland Management
  Christopher Dimario
  Rental Property Owner/Manager
  Cdimario@Marylandmgmt.com

- URI (Unlimited Restoration Inc)
  Rodney O'Neal
  Co-Owner
  ROneal@urinow.com

- Onyx renewable Partners
  Greg Cousoulas
  Sr VP of Construction
  On file

- Uhaul
  Jim Dickerson
  Owner Representative
  jim_dickerson@uhaul.com

GPR

Civil Engineering • Land Planning • Land Surveying

Engineering Solutions for Land & Structures

April 8, 2021
AMENDED August 16, 2021

City of Haverhill
City Council
4 Summer Street, Haverhill, MA 01830

RE: 139 Amesbury Line Road Solar Farm
Application for Solar Energy Special Permit (§7.8.11) and
Application for Water Supply Protection District (WSPD) Special Permit (§9.2.7)

Dear City Council:

On behalf of Solar Smart, LLC, the Applicant and Lessee, Goldsmith, Prest & Ringwall, Inc. (GPR) has compiled information below to support two special permit requests for the proposed 2 MW AC solar farm project at 139 Amesbury Line Road, City of Haverhill Assessors Property ID#430-11-12.

These special permit applications, including the plans and accompanying text, meet all the requirements to allow full evaluation of the proposed Large-Scale Ground-Mounted Solar Energy Use (hereinafter called the "Solar Lease Area") within the RS & RM Zoning Districts and within the City of Haverhill Water Supply Protection District (WSPD).

Introduction

The total land area of the subject property measures 26.81± acres, of which the proposed Solar Lease Area measures ~~18.40±~~ 18.60± acres. Approximately 2,505 square feet of ~~J~~jurisdictional wetlands present on the property shall ~~not~~ be altered and mitigated by wetland replication areas.~~, and~~ ~~w~~Work within wetlands and wetland buffer zones ~~shall be~~ is documented in a Notice of Intent filing to the City of Haverhill Conservation Commission.

The Solar Lease Area partially straddles a natural drainage divide between the Merrimack River (to the east) and the Millvale Reservoir (to the west). This natural drainage divide also defines the limits of the City of Haverhill Water Supply Protection District (WSPD) for the Millvale Reservoir, as well as a zoning district line between the RS (Special Rural) and RM (Medium Density) residential zones. The WSPD and RS are one and the same over the Solar Lease Area. The WSPD also places a Zone 'A' Surface Water Supply Protection Area on the subject property, outside the Solar Lease Area. The remainder of the WSPD on the Solar Lease Area is considered Zone 'C' Surface Water Supply Protection Area, and all disturbances shall be documented in a Notice of Intent filing to the City of Haverhill Conservation Commission.

The solar energy facility is allowed in all districts by Special Permit, except the Waterfront District, as stipulated under *City Ordinance Section 7.8.3.1*. The project is not located in any portion of a Waterfront District.

Solar Energy Special Permit Request

City Ordinance Section 7.8.11 Special Permit Criteria for the Large-Scale Ground-Mounted Solar Energy Systems use states:

> *"In addition to any other criteria set forth in this Ordinance for the grant of a special permit, the SPGA shall consider whether the grant of a special permit for a Large-Scale Ground-Mounted Solar Energy System will promote the highest and best use of the subject property, taking into account the characteristics of the subject property, including past land uses, possible presence of hazardous materials, and other development limitations."*

The proposed Solar Lease Area is currently forested, and slopes varying from 5% - 20% towards the Whittier School Driveway. The land is known to have been farmed in the past, and an old cart path and stone wall cuts generally east to west through the middle of the property, providing rough vehicular access and a scenic walking trail that has been used for several years.

The current WSPD overlay is built upon state code provisions in 314 CMR 4.00 Massachusetts Surface Water Quality Standards and 310 CMR 22.00 Drinking Water, in which there are numerous limitations on the installation of septic systems, animal farming, and uses of herbicides and pesticides, in order to protect and promote surface water quality. Test holes for drainage were dug, spaced across the Solar Lease Area, that identified relatively consistently shallow seasonal high groundwater depths.

Development options for the property are somewhat limited by the forementioned regulatory, topographic and subsurface groundwater constraints. Possible development options could include moderate-intensity organic farming, and limited residential development. These options, as well as leaving the land undeveloped, could comply with regulations and conform to the constraints of the land.

The proposed solar energy farm represents a highest and best use of the land within the various regulatory and physical constraints. The solar energy farm consists of construction materials and methods that produce no hazardous or toxic wastes or byproducts. At this location, a cooperative educational relationship is in development with Paul Moskevitz, the Vocational Technical Director of the Whittier Regional Vocational Technical School. The plan is to supply the school with access to weather and solar output data, along with access to resources for emerging technologies in energy systems engineering. Raised observation areas are proposed, along with a perimeter trail to maintain the old cart path walking connection. In addition to a WSPD compliant design, pollinator seeding areas are proposed and bee hives are to be installed to promote future generations of fruitful habitat in the area.

In a broader sense, our modern society that has been built on electrical infrastructure fueled by the combustion of fossil fuels, coal and natural gas, is sourcing other fuels, including solar. Local solar energy sources provide local power grids and end users with better options from distributed power generation. Improved battery technology to be employed at 139 Amesbury Line Road will also help buffer periods of peak power usage to add resilience to the local power grid. Over time, solar installations will provide renewable, distributed, redundant, and clean energy sources serving local communities directly.

Harnessing solar energy is a highest and best use for the land at 139 Amesbury Line Road, today and into the future, with the installation of mature solar technology, accompanied by the other proposed elements for environment and education.

Water Supply Protection District (WSPD) Special Permit Request
City of Haverhill Ordinance Section 9.2 Water Supply Protection District (WSPD) lists in *Section 9.2.7 Uses Permitted by Special Permit,* nine (9) articles describing qualified use categories which may be granted special permit by the City Council. The proposed solar energy facility qualifies for special permit under the fourth article, (*Ordinance Section 9.2.7.4*) which states:

> *"Any use otherwise permitted as of right or by special permit that requires a permit under the National Pollutant Discharge Elimination System permit program established pursuant to 33 U.S.C § 1342, the Surface Water Discharge Permit Program established pursuant to M.G.L. c.21, s.43, or the Groundwater Discharge Permit Program established pursuant to M.G.L. c. 21, s.43."*

As the solar energy facility is allowed by special permit in all but the WD District (§7.8.11), and greater than 1 acre of proposed land disturbance triggers a National Point Discharge Elimination System (NPDES) with the U.S. Environmental Protection Agency (EPA) under a Construction General Permit Notice of Intent (CGP-NOI), *Ordinance Section 9.2.7.4* allows the City Council to grant a WSPD Special Permit. The following is complete in all regards, meeting all the requirements of the City of Haverhill Ordinance to allow full evaluation of the proposed use on the Water Supply Protection District. The information is provided in sequence according to the numbering listed in the City of Haverhill Ordinance.

§9.2.8.1. Application. This Application has a list of all state, local and federal permits, licenses and approvals required for the proposed activity, and the status of all such permits, licenses and approvals:

Permit	Status
Haverhill Solar Energy Special Permit	Applied
Haverhill WSPD Special Permit	Applied
Haverhill Conservation Commission NOI	~~Not Yet~~ Applied
EPA CGP-NOI	Apply for Construction
General Contractor License	Pending Selection
Building Permit	Apply for Construction
Electrical Permit	Apply for Construction

§9.2.8.2. This application is prepared in accordance with the data requirements and BMPs of the proposed development (e.g., including but not limited to erosion and sedimentation control plan, stormwater requirements, septic system designs).

An updated Stormwater Management Report, Long-Term Pollution Prevention Plan and Stormwater O&M Plan prepared in accordance with the Massachusetts Stormwater Management Handbook, and in response to Peer Review comments to the Notice of Intent application, describing all BMP's is provided as attachment to this application. A Solar Facility O&M Manual is also provided as attachment. A complete updated site plan set is provided as attachment, to depict geometric layouts, grading, drainage, and erosion and sedimentation control plans and details.

§9.2.8.3. This application is required to include a complete list of chemicals, pesticides, fuels and other potentially hazardous materials to be used or stored on the premises in any quantity, however, there are none proposed with this project. The application shall include a Management Plan for the handling, storage and disposal of any materials identified.

Lithium-ion batteries used for energy storage and power transfer are proposed in fire-rated enclosures, with non-toxic fire suppression systems. Detailed technical information on these systems are included as attachment. No chemicals, pesticides, fuels or other potentially hazardous materials are proposed to be used or stored on the premises.

Electric transformers contain fluids for cooling. The transformers used on this project shall use Envirotemp™ 360 or FR3 fluid, which have the same general chemical composition as vegetable oil.

The proposed battery enclosures have a triple redundancy protection against failures. The modes of protection consist of:

1. The connex box itself is a sealed steel enclosure affixed to a concrete pad. The batteries are located inside the steel enclosure, protected from weather exposure.
2. An integrated cooling system and thermostat keeps the batteries from overheating.
3. The enclosure is equipped with a "FM-200™ Clean Agent Fire Suppression System" using the cleanest fire suppression technology available. A material safety data sheet for the active chemical, HFC-227ea is included in the appendix.

Should the cooling system fail, and the fire extinguishing system fail, any combustion of materials inside the steel connex container remains inside the container.

§9.2.8.4. This application includes an analysis by a professional Massachusetts licensed engineer experienced in groundwater evaluation to demonstrate that the proposed activity will not be detrimental to the purposes of this district as set forth in Section 9.2.1.

The proposed activity is not detrimental to the watershed to be protected.
The proposed solar panels, electrical equipment pads and gravel driveway do not generate TSS or other pollutants. The proposed drainage system provides stormwater recharge and peak flow attenuation in accordance with the standards of the Massachusetts Stormwater Management Handbook.

The site is within the watershed of the Millvale Reservoir. The existing ground surface within the project area is generally at a 15% slope draining towards the Whittier School driveway to the north. Roadside ditches along the Whittier School driveway capture runoff from the hillside and convey runoff under the road via three (3) concrete pipe culverts to a large wetland complex north of the driveway.

Two wetland areas on the subject property were flagged by wetland scientist Matthew S. Marro in September and October 2020. The third, larger wetland area on the north side of the Whittier School driveway was also flagged at this time. In July 2020, the Haverhill Conservation Commission hired a delineation consultant, Mary Rimmer of Rimmer Environmental Consulting, LTD who made changes and additions to the wetland delineation by Matthew Marro. The two consultants met and conferred on the delineation as shown on the Plan Amended 8/16/21, changing the shape of the two wetland areas and adding a third, isolated wetland area subject to the City of Haverhill Wetland Bylaw. Following the updated delineation, the project proposes wetland replication as mitigation for wetland impacts. The two primary wetland areas on the subject property form broad swales for conveyance of surface waters, and being at low points in the grade, these swales generally discharge into the drainage culverts under the Whittier School driveway. Some of the new delineated wetlands areas being impacted do not flow toward the Whittier driveway and are not in the WSPD.

On 1/8/2021 soil investigation of the property was conducted by Kyle Burchard, P.E., registered Massachusetts Soil Evaluator #14048. A series of drainage test pits were dug in several locations across the proposed development in order to identify estimated seasonal high groundwater elevations and existing soil conditions. Test hole logs are included in the Stormwater Management Report attached to this application. The seasonal high water table was identified fairly consistently at 27" below the ground surface according to mottles in the soil. The chroma in the strata below the estimated seasonal high groundwater was not significantly gleyed, indicating that the soils were typically saturated without a large amount of seasonal variation in the groundwater elevation that would tend to wash more of the chroma away. The soil profile and characteristics were consistent across the whole project area, being relatively shallow groundwater and a composition of sandy loam and loam.

The relatively shallow groundwater condition on the site, and the indication of nearly constant saturation supports the proposed site stormwater BMP strategy of minimal surface grading and no impervious pavement. Long, shallow-depth, and minimally-sloped grassed swales with check dams will be incised along the hillside to capture, slow, and promote runoff recharge to groundwater. The proposed shallow manipulation of surface soils achieves the minimum Massachusetts Stormwater Management Handbook Standards of matching pre-development to post-development peak flows, maintaining existing groundwater recharge, and promoting water quality.

The drainage calculations for the grassed swales, conveyance channels and detention basins in the Stormwater Management Report show appropriate compensation for the change in land cover from forested to grassed hillside and gravel driveway conditions.

The Massachusetts Stormwater Handbook targets a neutral stormwater impact with various BMP's and the assortment of measures proposed achieve that.

§9.2.9. Design and Performance Standards.
At the time of this application, the proposed Solar Lease Area area is wooded with a gravel cart path crossing through it from east to west, bounded on the south side by a stone wall. Other various stone walls mark some of the boundaries of the subject property. Two wetland fingers reach into the property from culverts under the adjacent Whittier School driveway to the north. The only known former use of the property was as farmland. There are no known septic fields, and no known hazardous materials on the property.

Access from Amesbury Line Road provides both temporary construction access, and permanent facility access for routine maintenance of the solar facility. This driveway access provides Fire and EMS access as well. The gravel access driveway will also be maintained as needed for stable passage. The first 280 feet of driveway from Amesbury Line Road will be treated in an alternative manner so as to appear like an old cart path, but with a stable construction meeting the approval of the Haverhill Fire Department. During construction a secondary construction access has been secured by agreement with the abutting property owner of 235 Amesbury Line Road. This secondary access will reduce construction traffic passage on the primary access driveway.

§9.2.9.1 Safeguards.
Three (3) pad-mounted and enclosed lithium-ion battery banks are proposed with the project. These three (3) large batteries are equipped with automatically deployed gaseous fire-suppression systems that suffocate any fire instantaneously without toxic residues.

Supports for the proposed solar panels consist of driven stainless-steel posts.

Buried wires and cabling are all waterproofed and insulated.

No toxic or hazardous materials or byproducts result from the solar farm installation.

§9.2.9.2. Location.
The WSPD boundary onsite has been delineated by the natural drainage divide.
Small deviations in the post-development drainage conditions are delineated on the drainage divide maps included with the Stormwater Management Report.
No toxic or hazardous discharges, nor septic discharges are proposed within the WSPD, or on the site.

§9.2.9.3. Disposal.
No onsite subsurface sewage disposal systems are proposed with this project.

§9.2.9.4. Stormwater.
The design of stormwater management measures conforms to the Massachusetts Stormwater Standards in all regards. See the Stormwater Management Report attached to this application.

The Applicant, based upon the testimony, plans and evidence submitted herewith and supplemented at the Public Hearing, respectfully requests that the City Council make a written determination and find that:

1. The proposed use or structure(s) shall not cause substantial detriment to the neighborhood or the City, taking into account the characteristics of the site and of the proposal in relation to that site.
2. There are Community energy needs which are served by this Project.
3. There is safe traffic and pedestrian flow provided by this Project.
4. There are adequate utilities and other public services for this Project.
5. The Natural Environment will not be impacted.
6. There is no impact on City services and this project will increase the city tax base.

In addition to meeting the above criteria set by Section 10.4.2, the Council can also find that the proposed use:

1. Satisfies the design and operations guidelines set forth in the Zoning Ordinance;
2. Is in harmony with the purposes and intent of this Section and will promote the purposes of the WSPD;
3. Is appropriate to the natural topography, soils, and other characteristics of the site to be developed;
4. Will not, during construction or thereafter, have an adverse environmental impact on any water body or watercourse in the district; and
5. Will not adversely affect the quality or quantity of an existing water supply.

The Applicant respectfully requests City Council approval of both the Solar Energy Special Permit and the Water Supply Protection District (WSPD) Special Permit.

Respectfully submitted,

Kyle Burchard, P.E.

Application Attachments:

Haverhill Solar Site Plan Set
Appendix 1- Solar Farm Components
Appendix 2- Stormwater Management Report and Operations & Maintenance Plan
Appendix 3- Solar Facility Operations & Maintenance Plan
Appendix 4- Construction Access Agreement
Appendix 5- Electrical One-Line Diagram
Appendix 6- Solar Site Illustratives
Appendix 7- Whittier School Sewer Plan

Copy to: Theodore Xenakis, Esq.
Solar Smart Development
Robert D. Harb, Esq.
GPR file 181084

SITE PLAN

HAVERHILL SOLAR PROJECT

HAVERHILL, MA

REGULATORY NOTES

1. CONTRACTOR SHALL CONTACT DIG-SAFE FOR UNDERGROUND UTILITY MARKING AT 888.344.7233 AT LEAST 72 HOURS PRIOR TO COMMENCEMENT OF ANY WORK. CONTRACTOR SHALL GIVE TWENTY-FOUR (24)-HOUR NOTICE TO PERTINENT TOWN DEPARTMENTS BEFORE COMMENCING ANY WORK IN THE FIELD.
2. CONTRACTOR SHALL COORDINATE AND OBTAIN ALL CONSTRUCTION PERMITS REQUIRED BY REGULATORY AUTHORITIES. INSPECTIONS OF DRIVEWAY AND DRAINAGE CONSTRUCTION AT CURRENT INSPECTION FEE RATES IS REQUIRED.
3. CONTRACTOR SHALL BE AWARE OF ALL CONSTRUCTION REQUIREMENTS, CONDITIONS, AND LIMITATIONS IMPOSED BY PERMITS AND APPROVALS ISSUED BY REGULATORY AUTHORITIES PRIOR TO COMMENCEMENT OF ANY WORK.
4. GENERAL COMPLIANCE WITH 28 CFR PART 36 - 2010 ADA STANDARDS FOR ACCESSIBLE DESIGN AND 521 CMR PART C, EXTERIOR OF THE MASSACHUSETTS ARCHITECTURAL ACCESS BOARD REGULATIONS IS INTENDED. CONTRACTOR SHALL VERIFY COMPLIANCE DURING CONSTRUCTION AND SHALL NOTIFY THE OWNER OF ANY NON-COMPLIANCE ISSUES AS SOON AS DISCOVERED.
5. LEDGE REMOVAL VIA BLASTING SHALL CONFORM TO 527 CMR 1.00 AND INCORPORATE THE HAVERHILL FIRE DEPARTMENT LEDGE BLASTING SPECIFICATIONS.

SITE DATA

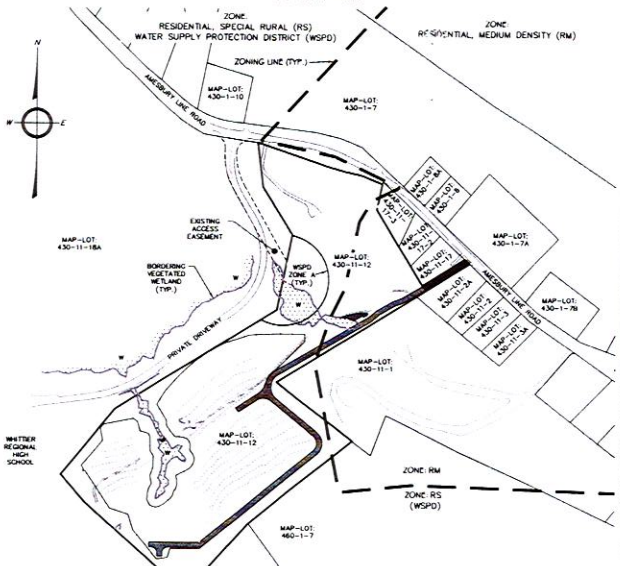
LOT AREA:	26.8 ±AC. (1,167,844 S.F.)
OPEN SPACE:	93% ±
SOLAR LEASE AREA:	18.6 ± AC (810,801 S.F.)

GENERAL NOTES

1. THE INTENT OF THIS SITE PLAN IS TO INSTALL A LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM, DRIVEWAY ENTRANCE AND DRIVEWAY WITH ALL REQUISITE FENCING, STORMWATER MANAGEMENT, AND OTHER APPROPRIATE INFRASTRUCTURE. THE DRIVEWAY WILL BE USED FOR ON-GOING, INFREQUENT ACCESS BY VEHICLES FOR THE PURPOSE OF ROUTINE MAINTENANCE OF THE SOLAR SYSTEM, AS WELL AS FOR EMERGENCY ACCESS.
2. UNDERGROUND POWER LINES ARE PROPOSED FOR THE ELECTRICAL INTERCONNECTION, SUBJECT TO FINAL ENGINEERING BY NATIONAL GRID.
3. LOCATIONS OF EXISTING UNDERGROUND UTILITIES/OBSTRUCTIONS/SYSTEMS SHOWN HEREON ARE APPROXIMATE ONLY. ALL UTILITIES/OBSTRUCTIONS/SYSTEMS MAY NOT BE SHOWN. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL UNDERGROUND UTILITIES/OBSTRUCTIONS/SYSTEMS, WHETHER OR NOT SHOWN HEREON.
4. UNLESS OTHERWISE SHOWN, ALL NEW UTILITIES SHALL BE UNDERGROUND.
5. BURIED UTILITIES SHALL BE INSTALLED IN ACCORDANCE WITH THEIR RESPECTIVE COMPANY SPECIFICATIONS.
6. CONSTRUCTION LAYOUT OF SITE IMPROVEMENTS SHALL BE PERFORMED BY A LICENSED PROFESSIONAL LAND SURVEYOR. LOCATIONS OF EXISTING FEATURES OR PROPOSED IMPROVEMENTS DERIVED BY SCALING DRAWINGS MAY NOT BE ACCURATE. SEE PLAN REFERENCES HEREON.
7. SAFETY MEASURES, CONSTRUCTION METHODS, AND CONTROL OF WORK SHALL BE RESPONSIBILITY OF CONTRACTOR.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR AND/OR REPLACEMENT OF ANY EXISTING UTILITY OR STRUCTURE DAMAGED DURING CONSTRUCTION THAT ARE NOT DESIGNATED FOR DEMOLITION AND/OR REMOVAL HEREON. DAMAGED UTILITY OR STRUCTURE SHALL BE REPAIRED TO THE SATISFACTION OF THEIR RESPECTIVE OWNERS.
9. ANY INTENDED REVISION OF THE HORIZONTAL AND/OR VERTICAL LOCATION OF IMPROVEMENTS TO BE CONSTRUCTED AS SHOWN HEREON SHALL BE REVIEWED AND APPROVED BY ENGINEER PRIOR TO IMPLEMENTATION.
10. CONTRACTOR SHALL NOTIFY ENGINEER UPON COMMENCEMENT OF CONSTRUCTION IN ORDER TO ENSURE THAT REQUIRED INSPECTIONS ARE PERFORMED IN A TIMELY AND EFFICIENT MANNER.
11. CONTRACTOR SHALL PROMPTLY NOTIFY ENGINEER UPON DISCOVERY OF ANY UNFORESEEN SURFACE OR SUBSURFACE CONDITIONS THAT MAY IMPACT SITE CONSTRUCTION.
12. FINISH RIM ELEVATIONS SHOULD MATCH PAVEMENT, GRADING OR LANDSCAPING, UNLESS SPECIFICALLY INDICATED OTHERWISE.
13. WHERE EXISTING UTILITY LINES/STRUCTURES ARE TO BE CUT/BROKEN DOWN/ABANDONED, LINES/STRUCTURES SHALL BE PLUGGED/CAPPED/FILLED IN ACCORDANCE WITH UTILITY OWNER REQUIREMENTS.
14. EROSION CONTROL MEASURES, SUCH AS SILT FENCE OR STRAW BALES AS MAY BE SHOWN HEREON, SHALL BE INSTALLED BEFORE EARTH DISTURBANCE OCCURS, AND SHALL SERVE AS THE LIMIT OF WORK.
15. WHERE THE WORD "INSTALL" IS USED HEREIN, IT IS INTENDED TO DIRECT CONTRACTOR TO "FURNISH, INSTALL, AND PLACE IN OPERATION" THE COMPONENT REFERRED TO.
16. LIMITS OF WORK SHALL BE STAKED IN THE FIELD PRIOR TO COMMENCEMENT OF CONSTRUCTION.
17. ALL STORM DRAIN PIPE TO BE SMOOTH INTERIOR HDPE PIPE, 2.0 PSI GASKETED JOINT, UNLESS OTHERWISE NOTED.
18. WHERE SHOWN, CONSTRUCTION NOTES ARE INTENDED TO SUMMARIZE AND CLARIFY MAJOR ITEMS OF WORK. THESE NOTES SHOULD NOT BE CONSTRUED AS AN EXHAUSTIVE LISTING OF ALL WORK REQUIRED. CONTRACTOR SHOULD CONTACT ENGINEER WHEN FURTHER CLARIFICATION OF DEPICTED WORK IS DESIRED.
19. NO DEBRIS, JUNK, RUBBISH OR OTHER NON-BIODEGRADABLE MATERIALS, FILL CONTAINING HAZARDOUS MATERIALS OR WASTES, OR STUMPS SHALL BE BURIED ON ANY LAND ON THIS SITE, OR LEFT ON ANY LOT OR ON THE STREET RIGHT OF WAY.

VICINITY MAP

SCALE: 1" = 600'



OVERALL MAP & ZONING

SCALE: 1" = 250'

SHEET INDEX

ASSESSORS REFERENCE

ASSESSORS MAP 430, BLOCK 11, LOT 12

SUBMITTALS

1. COORDINATE POWER AND COMMUNICATIONS SERVICE WITH UTILITY COMPANIES. SUBMIT UTILITY GENERATED LAYOUT PLAN(S) TO ENGINEER FOR APPROVAL PRIOR TO ANY CONSTRUCTION.
2. SPECIAL PERMIT TO CITY COUNCIL FOR CONSTRUCTION OF LARGE-SCALE GROUND-MOUNTED SOLAR ENERGY SYSTEM.
3. SPECIAL PERMIT TO CITY COUNCIL FOR CONSTRUCTION IN WATER SUPPLY PROTECTION DISTRICT (WSPD).
4. SUBMIT SITE PLAN TO CITY OF HAVERHILL DEVELOPMENT REVIEW FOR CONSTRUCTION OF LARGE-SCALE GROUND MOUNTED SOLAR ENERGY SYSTEM.
5. SUBMIT NOTICE OF INTENT TO CITY OF HAVERHILL CONSERVATION COMMISSION FOR REVIEW FOR WORK THAT FALLS UNDER THE MASSACHUSETTS WETLAND PROTECTION ACT AND CITY OF HAVERHILL WETLAND PROTECTION ORDINANCE.

ZONING

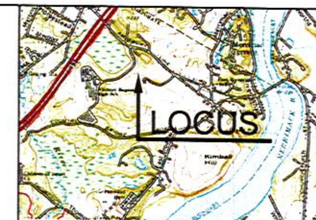
Parameter	Section [1]	Requirement	Remarks
Zoning District	2.1.1 & Zoning Map	RS / RM	Special Rural (residential) & medium density (residential)
Overlay District	2.1.2 & Zoning Map	WSPD	WSPD (Water Supply Protection District)
			9.2.7
Proposed Use	7.8.3	Allowed by SPGA	Large-Scale Ground-Mounted Solar Energy Systems
		RS / RM	
Lot Area	Appendix B-Table 2	87,120 SF / 20,000 SF	1,167,844 SF
Frontage	Appendix B-Table 2	200 FT / 150 FT	583 FT
Lot Depth	Appendix B-Table 2	150 FT / 100 FT	1900 FT
Yard	Appendix B-Table 2	Special / residential / solar	Use Solar Dimensions
Front	Appendix B-Table 2	40 FT / 25 FT / 100 FT	100 FT (7.8.6-1.a.)
Side	Appendix B-Table 2	25 FT / 15 FT / 100 FT	100 FT (7.8.6-1.b.)
Rear	Appendix B-Table 2	25 FT / 30 FT / 100 FT	100 FT (7.8.6-1.c.)
Building Height	Appendix B-Table 2	35 FT / 35 FT	N/A
Maximum Stories	Appendix B-Table 2	2.5 / 2.5	N/A
Building Coverage	Appendix B-Table 2	15 % / 25 %	N/A
Floor Area Ratio	Appendix B-Table 2	None	N/A
Open Space (MIN.)	Appendix B-Table 2	70 % / 45 %	93.95%
Parking	9.3.15	see table	
Driveways and Entrances	7.8.7	see bylaw	
Wetlands Setback	253-8	100 feet from resource area	35' no disturbance, 75' no structure
Zone A, B, C	255-18		See Resource Impact Map (sheet C3.2)
MDEP Riverfront Area	N/A		none on site
FEMA Floodplain	25009C0092F		none on site
ACEC	N/A		none on site
NHESP	N/A		none on site
Zone 1 Protective Radius	N/A		none on site
Mapped Zone 2	N/A		none on site
IWPA	N/A		none on site

NOTES:

[1] Reference to section of Zoning Bylaw, where applicable.

ABBREVIATIONS:

SF=square feet; CF=cubic feet; FT=feet; GFA=gross floor area; GPD=gallons per day; AC=acres;
WSPD=Water Supply Protection District; ZBA=Zoning Board of Appeals; SPGA=Special Permit Granting Authority



LOCUS MAP

1" = 2000'

ELEVATION DATUM

DATUM: NAVD 1988

B.M. NO.1

EXISTING CONDITIONS NOTES:

1. EXISTING CONDITION INFORMATION BASED ON AN ON-THE-GROUND TOPOGRAPHIC AND BOUNDARY SURVEY PERFORMED BY GOLDSMITH, PREST & RINGWALL, INC. OCTOBER 2020.
2. EDGE OF WETLAND DELINEATED BY MATTHEW MARRO-PRINCIPAL CONSULTANT OF MATTHEW S. MARRO ENVIRONMENTAL CONSULTING, DATED OCTOBER 2020.

PLAN REFERENCES

A. "EFFLUENT SEWER AND GROUND RECHARGE BEDS" BY DRUMMEY ROSANE ANDERSON (DRA) OF NEWTON LOWER MASS, DATED 1/4/79, PROVIDED BY WHITTIER SCHOOL.

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION
■ PERMIT ☐ CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.

COMMONWEALTH OF MASSACHUSETTS
KYLE BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED PROFESSIONAL ENGINEER

Kyle Burchard 8/16/21

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION; LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES; DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS

GPR Engineering Solutions for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.
39 MAIN STREET, SUITE 301, AYER, MA 01432
CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978.772.1590 FAX: 978.772.1591
www.gpr-inc.com

SOLAR PHOTOVOLTAIC PROJECT

TITLE SHEET

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB / CHK. BY: KFB	DATE: APRIL 2021	JOB 181084	C1.1

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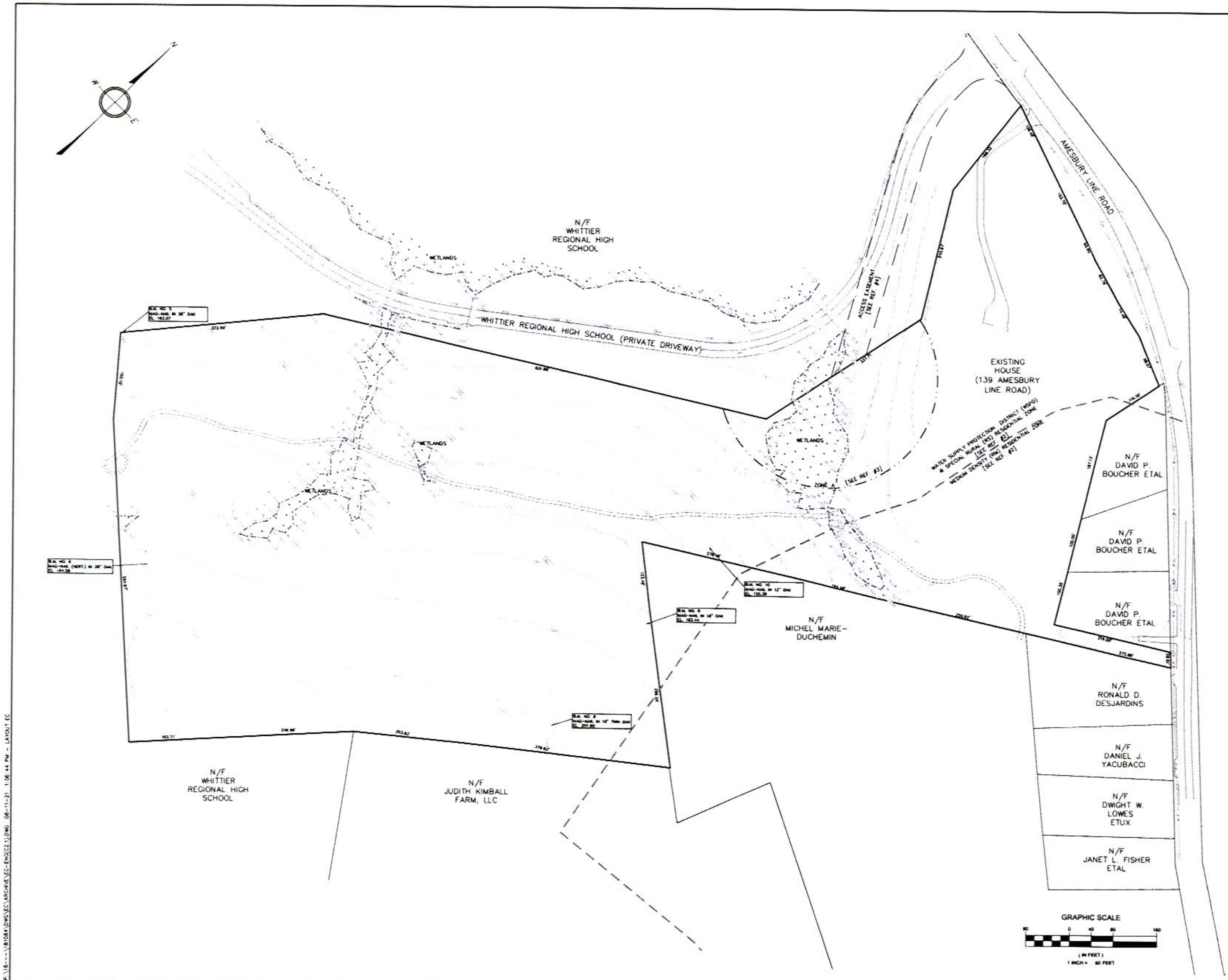

LEGEND

EXISTING

- ELEVATION CONTOUR
- SPOT GRADE
- PROPERTY LINE
- WETLAND DELINEATION
- EDGE OF PAVEMENT
- GRAVEL/DIRT TRAIL
- CAPE COD BERM CURBING
- STONE WALL
- WATER VALVE
- FIRE HYDRANT
- GRAVITY SEWER LINE
- SEWER MANHOLE
- OVERHEAD POWER LINE
- UTILITY POLE
- STORM DRAIN
- DRAIN MANHOLE
- DEEP SOIL OBSERVATION HOLE
- ELEVATION BENCHMARK
- EDGE OF TREELINE

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
AC	ACRES	N/F	NOW OR FORMERLY
FT	FEET	VP	VERNAL POOL
R	RADIUS	WF	WETLAND FLAG
DIA	DIAMETER	TW	TOP OF WALL
BIT	BITUMINOUS	BW	BOTTOM OF WALL
CONC	CONCRETE	FG	FINISH GRADE
L	LENGTH	BSMT	BASEMENT
S	SLOPE	FF	FINISH FLOOR

PLAN REFERENCES

1. "PLAN OF LAND IN HAVERHILL, MASS." DRAWN FOR THEODORE XENAKIS BY MERRIMACK ENGINEERING SERVICES. DATED DECEMBER 1981. ESSEX DISTRICT REGISTRY OF DEEDS PLAN BOOK 176, PLAN 36.
2. "CITY OF HAVERHILL MASSACHUSETTS ZONING WITH WATERSHED & INDEX MAP-2017" BASED ON PLAN OVERLAY PROVIDED BY THE HAVERHILL DEPARTMENT OF ECONOMIC DEVELOPMENT & PLANNING.
3. EDGE OF ZONE A BASED ON PLAN OVERLAY PROVIDED BY OLIVER: MASS GIS.
4. "PLAN OF LAND IN HAVERHILL MASS SHOWING EASEMENT LOCATION" PREPARED BY STOWERS ASSOCIATES REG LAND SURVEYORS. DATED MARCH 1970. ESSEX REGISTRY OF DEEDS PLAN BOOK 116 PLAN 76

ASSESSORS REFERENCE:

ASSESSORS MAP 430, PARCEL 11, LOT 12, 26.8 ACRES

EXISTING CONDITIONS NOTES:

1. EXISTING CONDITION INFORMATION BASED ON AN ON-THE-GROUND TOPOGRAPHIC AND BOUNDARY SURVEY PERFORMED BY GOLDSMITH, PREST & RINGWALL, INC. OCTOBER 2020.
2. EDGE OF WETLAND DELINEATED BY MATTHEW MARRO–PRINCIPAL CONSULTANT OF MATTHEW S. MARRO ENVIRONMENTAL CONSULTING, DATED OCTOBER 2020, AND MODIFIED BY MARY RIMMER OF RIMMER ENVIRONMENTAL CONSULTING, LLC IN JULY 2021. ALL WETLAND DELINEATION FLAGS SURVEYED BY GPR IN OCTOBER 2020 AND JULY 2021.

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION
■ PERMIT ☐ CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.

COMMONWEALTH OF MASSACHUSETTS
DAVID J. DeBAY 33887
PROFESSIONAL LAND SURVEYOR

8/11/2021

NO.	DATE	BY	APP.	REVISION DESCRIPTION
1	8/11/2021	JFB	KFB	REVIEW COMMENTS & ADDED WETLAND AREAS

GPR Engineering Solutions for Land & Structures

GOLDSMITH, PREST & RINGWALL, INC.
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CIVIL ENGINEERING • LAND SURVEYING • LAND PLANNING
VOICE: 978.772.1590 FAX: 978.772.1591
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SOLAR PHOTOVOLTAIC PROJECT

EXISTING CONDITIONS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: KFB / CHK. BY: DJD	DATE:	APRIL 2021	JOB 181084	C2.1

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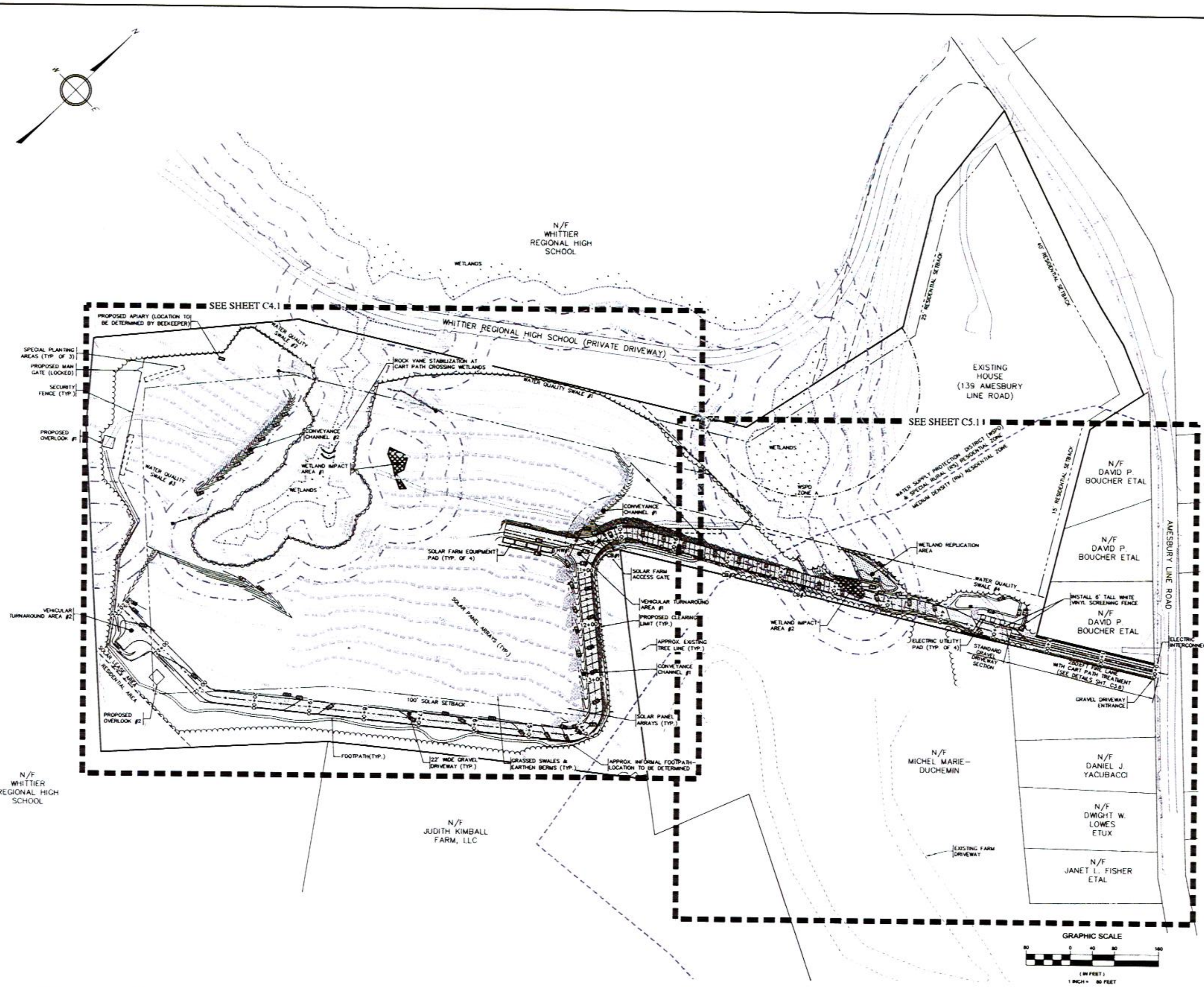

LEGEND

EXISTING		PROPOSED
	ELEVATION CONTOUR	
	SPOT GRADE	
	PROPERTY LINE	
	WETLAND DELINEATION	
	WETLAND BUFFER ZONE	
	SHORELINE	
	SOLAR LEASE AREA	
	PROPERTY LINE SETBACK	
	100-YEAR FLOODPLAIN LIMIT	
	EDGE OF PAVEMENT	
	CAPE COD BERM CURBING	
	GRANITE CURBING	
	GRAVEL/DIRT ROAD	
	STOCKADE FENCE	
	STONE WALL	
	WATER MAIN	W
	WATER SERVICE	WS
	FIRE SERVICE	FS
	WATER VALVE	WV
	FIRE HYDRANT	
	FORCE MAIN	FM
	GRAVITY SEWER LINE	SS
	SEWER MANHOLE	SMH
	GAS LINE	
	GAS SERVICE	GS
	GAS VALVE	
	BURIED POWER LINE	E
	OVERHEAD POWER LINE	
	UTILITY POLE	
	GUY WIRE	
	ELECTRIC BOX	E
	STORM DRAIN	SD
	UNDERDRAIN	UD
	ROOF DRAIN	RD
	FOUNDATION DRAIN	FD
	CATCH BASIN	
	DRAIN MANHOLE	
	DEEP SOIL OBSERVATION HOLE	
	MAILBOX	
	SITE LUMINAIRE	
	SIGN	
	ELEVATION BENCHMARK	
	SURFACE RUNOFF DIRECTION	
	STONE BOUND	
	DRILL HOLE	
	IRON ROD	

ABBREVIATIONS

EL	ELEVATION	HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT	PVC	POLYVINYL CHLORIDE
SF	SQUARE FEET	RCP	REINFORCED CONCRETE PIPE
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COMMONWEALTH OF MASSACHUSETTS KYLE BURCHARD CIVIL ENGINEER NO. 54142 REGISTERED PROFESSIONAL ENGINEER

8/16/21

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION; LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES; DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP.	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS

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SOLAR PHOTOVOLTAIC PROJECT

OVERALL SITE PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C3.1
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RESOURCE IMPACT MAP LEGEND

- 35'-75' WETLAND BUFFER ALTERATION
- 75'-100' WETLAND BUFFER ALTERATION
- TREE AND VEGETATION REMOVAL

RESOURCE IMPACT SUMMARY

BVW AREAS

AREA #1	1,185 S.F.
AREA #2	1,320 S.F.
TOTAL	2,505 S.F.

BUFFER IMPACT SUMMARY

0'-35' WETLAND BUFFER	
AREA #1	10,581 S.F.
AREA #2	7,193 S.F.
35'-75' WETLAND BUFFER	
AREA #1	62,294 S.F.
AREA #2	11,586 S.F.
75'-100' WETLAND BUFFER	
AREA #1	44,111 S.F.
AREA #2	8,186 S.F.
TOTAL	143,951 S.F.

WSPD IMPACT SUMMARY

WSPD ZONE A	
DISTURBED AREA	0
WSPD ZONE C	
DISTURBED AREA	603,375 S.F.
TOTAL	603,375 S.F.

TREE IMPACT SUMMARY

TREES 10" DBH OR GREATER TO BE REMOVED

TOTAL 715 TREES

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COMMONWEALTH OF MASSACHUSETTS
KYLE
BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED
PROFESSIONAL ENGINEER

8/16/21

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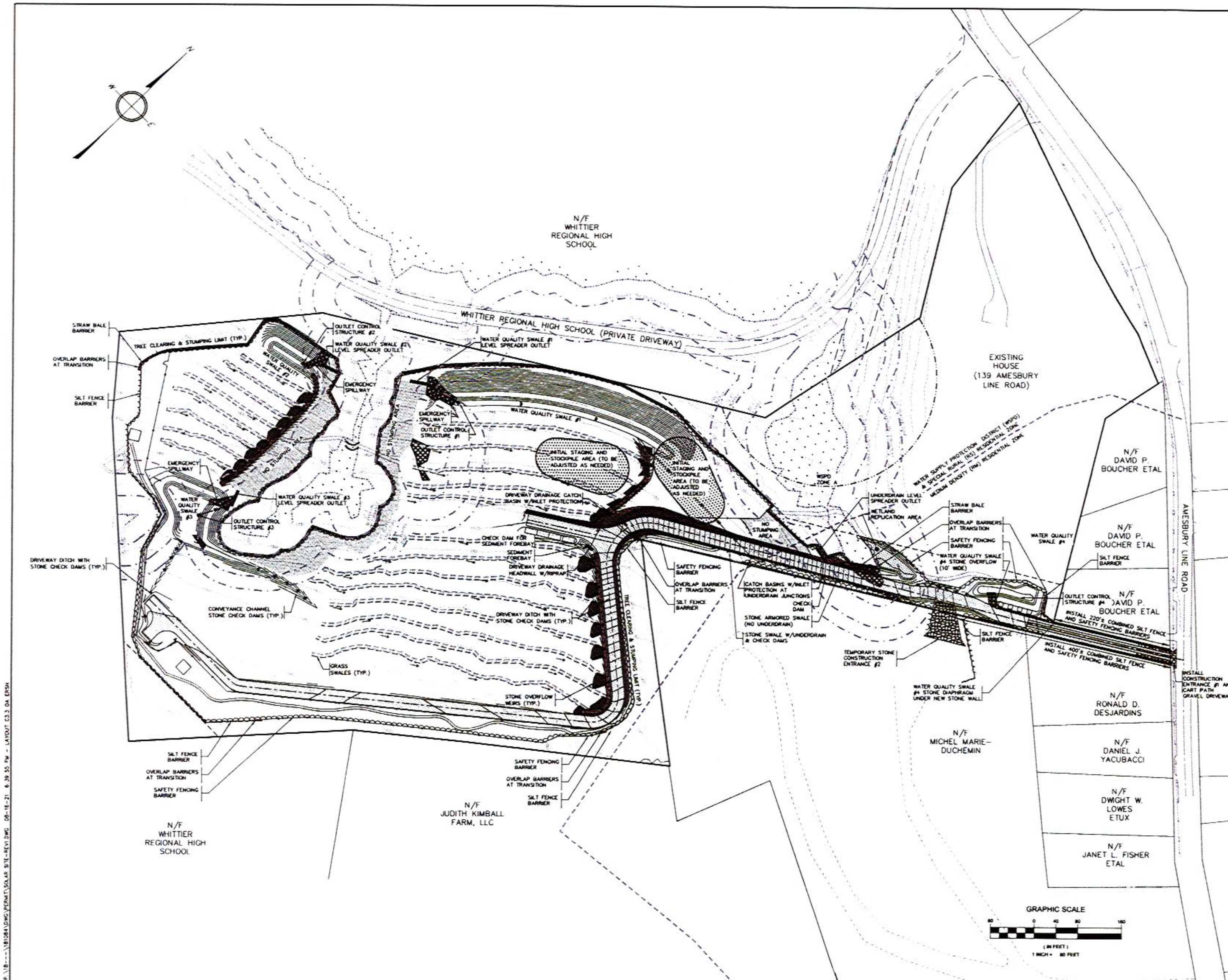
SOLAR PHOTOVOLTAIC PROJECT

RESOURCE IMPACT MAP

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB / CHK. BY: KFB	DATE:	APRIL 2021	JOB 181084	C3.2



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COMMONWEALTH OF MASSACHUSETTS KYLE BURCHARD CIVIL ENGINEER NO. 54147 REGISTERED PROFESSIONAL ENGINEER

8/16/21

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SOLAR PHOTOVOLTAIC PROJECT

EROSION AND SEDIMENT CONTROL PLAN

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB	DATE: APRIL 2021	JOB 181084	C3.3
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EROSION AND SEDIMENT CONTROL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. FURNISH, INSTALL, AND MAINTAIN TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES ACROSS ALL AND EVERY GROUND SURFACE THAT IS ALTERED BY CONSTRUCTION THAT IS NOT OTHERWISE PERMANENTLY STABILIZED BY PERMANENT DRIVEWAY SURFACES. TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES SHALL CONSIST OF, BUT NOT NECESSARILY LIMITED TO, STRAW BALE AND SILT FENCE BARRIERS, RIPRAP, SILT BAGS, DIVERSION CHANNELS AND BERMS, BYPASS PUMPS/INTAKE FILTERS/HOSES, CHECK DAMS, STRATEGICALLY LOCATED STOCKPILES, SEDIMENT BASINS, MULCH, LOAM AND SEED MIX (HEREINAFTER "CONTROL MEASURES") ADEQUATE TO PREVENT THE CONVEYANCE OF EROSION PRODUCTS (E.G. SOIL, MULCH, SOD) OFF SITE, OR INTO ENVIRONMENTALLY SENSITIVE AREAS, OR INTO AREAS WHERE WORK WILL BE ADVERSELY IMPACTED. ENVIRONMENTALLY SENSITIVE AREAS INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, WETLANDS, TRIBUTARIES TO WETLANDS, WETLAND BUFFER ZONES, INTERMITTENT AND PERENNIAL STREAMS / RIVERS, AND THEIR ATTENDANT BUFFER ZONES.

1. REFER TO DRAWINGS FOR LOCATION AND DETAILS OF CONTROL MEASURES REQUIRED TO COMMENCE WORK. THESE CONTROL MEASURES WILL BE ADEQUATE ONLY FOR VEGETATION CLEARING. THE DRAWINGS ARE NOT INTENDED TO GRAPHICALLY DEPICT ALL CONTROL MEASURES THAT WILL BE REQUIRED TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A.
2. DEVISE AND EMPLOY CONTROL MEASURES THROUGHOUT THE DURATION OF PROJECT, OVER ALL AREAS DISTURBED OR UNDISTURBED BY CONSTRUCTION, AS NECESSARY TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A.
3. DEVISE AND EMPLOY TEMPORARY CONTROL MEASURES AS NECESSARY TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A, WHILE ALLOWING WORK TO PROCEED IN AN EFFICIENT, COST EFFECTIVE MANNER.
4. DEVISE, EMPLOY AND MAINTAIN CONTROL MEASURES UNTIL SUCH TIME AS THE ENTIRE SITE IS PERMANENTLY STABILIZED BY ESTABLISHED VEGETATION, FINISH LANDSCAPE MATERIALS, PAVED SURFACES, AND/OR ROOF AREA.
5. ONCE THE SITE IS PERMANENTLY STABILIZED AND CERTIFIED AS SUCH BY ENGINEER, REMOVE TEMPORARY CONTROL MEASURES WHILE PROTECTING STABILIZED SURFACES.

1.02 SUBMITTALS

A. SUBMIT PRODUCT DATA, WARRANTY, AND TEST REPORTS AS INDICATED ON THE DRAWINGS.

B. DUE TO THE SIZE OF THE PROJECT AND MORE THAN 1 ACRE OF LAND DISTURBANCE, A CONSTRUCTION GENERAL PERMIT (CGP) IS REQUIRED TO BE FILED WITH THE US ENVIRONMENTAL PROTECTION AGENCY (EPA) UNDER ITS NON-POINT DISCHARGE ELIMINATION SYSTEM (NPDES) PROGRAM, CONSISTING OF AT MINIMUM, AN NPDES NOTICE OF INTENT AND A STORMWATER POLLUTION PREVENTION PLAN (SWPPP).

1.03 QUALITY ASSURANCE

A. COMPLY WITH GOVERNING CODES AND REGULATIONS. PROVIDE PRODUCTS FROM ACCEPTABLE MANUFACTURERS. USE EXPERIENCED INSTALLERS. DELIVER, HANDLE, AND STORE MATERIALS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.

B. CONFORM TO CONDITIONS OF APPROVAL ISSUED BY REGULATORY AGENCIES INCLUDING, BUT NOT NECESSARILY LIMITED TO, LOCAL PLANNING BOARD, CONSERVATION COMMISSION, BOARD OF SELECTMEN, BOARD OF HEALTH, PUBLIC WORKS / HIGHWAY DEPARTMENT, STATE ENVIRONMENTAL PROTECTION DEPARTMENT, AND U.S. GOVERNMENT, ENVIRONMENTAL PROTECTION AGENCY. WHERE CONDITIONS OF REGULATORY APPROVAL DIFFER FROM REQUIREMENTS CONTAINED HEREIN OR ON THE DRAWINGS, COMPLY WITH THE MORE STRINGENT REQUIREMENT.

PART 2 – PRODUCTS

2.01 MATERIALS

A. STRAW BALES: MACHINE BOUND WITH JUTE OR WIRE, APPROXIMATE SIZE EACH BALE 42" X 16" X 16".

B. SILT FENCE: NON-WOVEN, UV-RESISTANT, POLYPROPYLENE FABRIC, FLOW RATED AT 10 GPM/SF MINIMUM, GRAB TENSILE RATED AT 124 POUNDS MINIMUM, WITH INTEGRAL STAKE LOOPS, AND HARDWOOD STAKES. USE NO. 2130 BY AMOCO FABRICS & FIBERS, OR APPROVED EQUAL.

C. MULCH: ORGANICS INCLUDING HAY, PROCESSED PINE / HEMLOCK TWIGS AND NEEDLES.

D. SEED MIXES: PERENNIAL RYEGRASS, KENTUCKY BLUEGRASS, AND / OR FINE FESCUE, DISEASE RESISTANT. NON-MAINTAINED AREA OPTION – ANNUAL RYEGRASS COMBINED WITH MEDIUM RED CLOVER.

E. EXCELSIOR BLANKET: CURLED WOOD FIBER ON PHOTODEGRADABLE EXTRUDED PLASTIC MATRIX, 80% OF FIBERS 6-INCHES LONG OR LONGER, WEIGHT 0.975 POUNDS / SY, CONTAINING NO CHEMICAL ADDITIVES. USE CURLEX I BLANKET BY AMERICAN EXCELSIOR COMPANY, OR APPROVED EQUAL.

F. ROCK RIPRAP: SOUND, ANGULAR, 6-INCH MINUS PROCESSED ROCK, BLAST ROCK, OR TAILINGS.

G. CRUSHED STONE: SOUND, ANGULAR, 2-INCH MINUS PROCESSED CRUSHED STONE

PART 3 – EXECUTION

3.01 THROUGHOUT CONSTRUCTION

A. DEVISE WORK SEQUENCE SO AS TO LIMIT DRAINAGE AREA THAT IS TRIBUTARY TO DISTURBED AREAS. DEVISE, EMPLOY, AND MAINTAIN CONTROL MEASURES SUCH AS DIVERSION CHANNELS AND BERMS, STRATEGICALLY LOCATED STOCKPILES, AND SEDIMENT BASINS TO SUBDIVIDE DRAINAGE AREAS INTO SMALL, MANAGEABLE SUBAREAS, THEREBY MINIMIZING RUNOFF AND THE POTENTIAL FOR EROSION.

B. MAINTAIN BARRIER AT LIMIT OF WORK AND PROTECT EXISTING VEGETATION / FACILITIES OUTSIDE OF LIMIT OF WORK.

C. MAINTAIN SPARE MATERIAL STOCKPILES FOR IMMEDIATE EMPLOYMENT / REPAIR / EXPANSION OF CONTROL MEASURES. AT A MINIMUM, SUCH MATERIALS SHALL INCLUDE STRAW BALES, SILT FENCE AND STAKES, AND CRUSHED STONE.

D. INSPECT AND MAINTAIN EFFECTIVENESS OF CONTROL MEASURES BY REPAIRING AS NECESSARY TO ENSURE INTENDED FUNCTION; BY SUPPLEMENTING AS NECESSARY FOR ADEQUATE EXTENT; BY REMOVING TRAPPED PRODUCTS OF EROSION AS NECESSARY TO MAINTAIN EFFECTIVE TRAP VOLUME.

E. LIMIT EXTENT OF WORK AREA SO THAT ALL DISTURBED AREAS CAN BE STABILIZED WITH CONTROL MEASURES WITHIN A 24-HOUR PERIOD. IN NO EVENT SHALL A GROUND SURFACE, SLOPE OR STOCKPILE BE LEFT DENUDED FOR MORE THAN 14 DAYS WITHOUT APPLICATION OF TEMPORARY OR PERMANENT SURFACE STABILIZATION PRACTICES.

F. INSTALL CONTROL MEASURES AS SOON AS PRACTICABLE AFTER EACH MANAGEABLE PORTION OF EARTHWORK IS COMPLETE. EMPLOY TEMPORARY MEASURES AS NECESSARY TO STABILIZE DISTURBED AREAS, EVEN WHERE SUBSEQUENT CONSTRUCTION OPERATIONS MAY REQUIRE RE-DISTURBANCE.

G. WHEN INTENSE RAINFALL IS EXPECTED, CONSIDER, DEVISE, AND EMPLOY REINFORCING CONTROL MEASURES PRIOR TO THE RAINFALL EVENT TO MEET THE REQUIREMENTS DESCRIBED IN 1.01.A. IF NECESSARY, EMPLOY TEMPORARY CONTROL MEASURES ON MATERIAL STOCKPILES TO COUNTERACT POTENTIAL SEDIMENT TRANSPORT DURING INTENSE RAINFALL.

H. WHEN VEHICLE REFUELING IS REQUIRED ON SITE, CONDUCT REFUELING OPERATIONS OUTSIDE OF ENVIRONMENTALLY SENSITIVE AREAS.

I. PROPERLY DISPOSE OF DEBRIS, SOLID WASTE, TRASH, AND CONSTRUCTION WASTE / BYPRODUCTS OFF SITE.

J. SWEEP ON-SITE PAVED AREAS AND OFF-SITE STREETS AS NECESSARY TO PREVENT SILT AND DEBRIS ORIGINATING ON SITE FROM ENTERING CLOSED DRAINAGE SYSTEMS AND / OR ENVIRONMENTALLY SENSITIVE AREAS.

3.02 SITE PREPARATION AND ACCESS

A. WALK SITE AND IDENTIFY LOCATIONS OF LIMIT OF WORK AND ENVIRONMENTALLY SENSITIVE AREAS. ESTABLISH CONSTRUCTION STAGING AREA, LOCATED BEYOND ENVIRONMENTALLY SENSITIVE AREAS.

B. INSTALL CONTROL MEASURES AS SHOWN ON THE DRAWINGS, INCLUDING THOSE DEFINING THE LIMIT OF WORK.

C. LIMIT VEHICULAR TRAFFIC TO AND FROM SITE TO MINIMIZE TRANSPORT OF SEDIMENT.

3.03 CLEARING, GRUBBING, AND STRIPPING

A. SCHEDULE GRUBBING AND STRIPPING TO OCCUR IMMEDIATELY PRIOR TO EARTH DISTURBANCE. DEPENDING ON SITE AREA, CONSIDER MULTIPLE GRUBBING PHASES, SEQUENCED TO TAKE ADVANTAGE OF THE EROSION PREVENTION POTENTIAL OF EXISTING VEGETATIVE COVER.

B. MINIMIZE THE AREA OF EXISTING VEGETATION REMOVED WHEREVER POSSIBLE.

C. LOCATE AND SIZE STOCKPILES TO MINIMIZE EROSION POTENTIAL, TAKING ADVANTAGE OF TERRAIN SLOPE AND ASPECT, WHERE APPROPRIATE.

D. PROTECT VEGETATION, INCLUDING ROOT SYSTEMS, BEYOND LIMIT OF CLEARING.

E. PROCESS TIMBER, STUMPS, SLASH, AND BRUSH SO AS TO PROTECT ENVIRONMENTALLY SENSITIVE AREAS AND INSTALLED CONTROL MEASURES. PROPERLY DISPOSE OF EXCESS OFF SITE. BURIAL OF STUMPS ON SITE IS PROHIBITED.

3.04 EXCAVATION FOR BUILDING FOUNDATIONS AND UTILITIES

A. DEVISE AND INSTALL CONTROL MEASURES ADEQUATE TO HANDLE DISCHARGES AND TRAP SEDIMENT FROM FOOTING SUMP AND WELL POINT PUMPS PRIOR TO EXCAVATION.

B. ARMOR SUMP PUMP DISCHARGE LOCATIONS TO PREVENT EROSION AT POINT OF DISCHARGE AND AREAS DOWNSTREAM.

C. IF FOUNDATION EXCAVATIONS GRADE TO DAYLIGHT ON THE LOW SIDE, DEVISE AND INSTALL CONTROL MEASURES TO HANDLE SURFACE AND GROUNDWATER FLOW FROM EXCAVATION LOW POINT.

D. STOCKPILE EXCAVATED MATERIALS TO BAFFLE OVERLAND RUNOFF, AVOIDING THE CREATION OF LENGTHY PATHS OF CONCENTRATED RUNOFF.

E. BACKFILL UTILITY TRENCHES AS SOON AS PRACTICABLE TO PREVENT FLOODING, SLOUGHING, POTENTIAL OVERFLOW, AND REPETITIVE EARTH DISTURBANCE.

3.05 SITE GRADING

A. WHERE APPLICABLE, FOLLOW EXCAVATION AND FILL PRACTICES SHOWN ON DRAWINGS TO LOCALIZE AND MINIMIZE EROSION.

B. MONITOR SEDIMENT VOLUME IN TEMPORARY SEDIMENT BASINS AND AT DIVERSION BERMS AND CHECK DAMS. IN ALL AREAS EXCEPT THOSE THAT DO NOT PRESENT POTENTIAL PROBLEMS WITH REGARD TO FUTURE SOIL STABILITY, DRAINAGE, OR BEARING CAPACITY, REMOVE AND PROPERLY DISPOSE OF TRAPPED SEDIMENT BEFORE BRINGING SITE TO FINAL SUBGRADE.

3.06 STORMWATER MANAGEMENT SYSTEM

A. THE STORMWATER MANAGEMENT SYSTEM INCLUDES, BUT IS NOT NECESSARILY LIMITED TO, ALL PERMANENT DETENTION / RETENTION BASINS, DISCHARGE STRUCTURES / WEIRS, CULVERTS, OPEN CHANNELS, CURBS, GUTTERS, PAVED SWALES, CATCH BASINS, DRAIN MANHOLES, DRAINAGE PIPES, ROOF DRAIN MANIFOLDS, WATER QUALITY SWALES, SEPARATORS, AND SIMILAR STORMWATER RUNOFF CONVEYANCE, TREATMENT, AND STORAGE FACILITIES.

B. INSTALL STORMWATER MANAGEMENT SYSTEM COMPONENTS STARTING AT THE DOWNSTREAM END AND PROCEED UPSTREAM. WHERE POSSIBLE, COMPLETE INSTALLATION OF PERMANENT DETENTION / RETENTION BASINS PRIOR TO BEGINNING WORK ON UPSTREAM SYSTEM COMPONENTS.

C. INSTALL CONTROL MEASURES AT FINISHED UPSTREAM AND DOWNSTREAM PIPE ENDS AS SOON AS POSSIBLE AFTER COMPLETION OF PIPE RUN. SUCH MEASURES INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, RIPRAP, CHECK DAMS, STRAW BALE / SILT FENCE BARRIERS, AND VELOCITY DISSIPATORS.

D. AT THE END OF EACH DAY OR WHEN RAINFALL IS EXPECTED, PLUG UPSTREAM END OF PIPES / DAM OPEN CHANNELS OR OTHERWISE REDIRECT POTENTIAL RUNOFF AND PREVENT FLOW FROM ENTERING PARTIALLY COMPLETED SYSTEM / SYSTEM COMPONENTS.

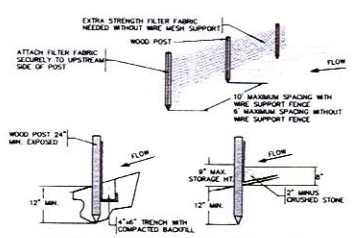
E. WHERE PORTIONS OF A NEW SYSTEM, ESPECIALLY FOR INFILTRATION BASINS, ARE TO BE ACTIVATED PRIOR TO COMPLETION OF THE ENTIRE SYSTEM, EMPLOY CONTROL MEASURES TO PREVENT SILT AND DEBRIS FROM ENTERING THE SYSTEM. EMPLOY SILT SACKS OR FABRIC ON CATCH BASIN INLETS, AND PIPE AND CULVERT OPENINGS. EMPLOY CHECK DAMS AND TEMPORARY SEDIMENT BASINS UPSTREAM OF AND ALONG OPEN CHANNELS, SWALES, AND DITCHES TO TRAP SEDIMENT UPGRADIENT OF ENVIRONMENTALLY SENSITIVE AREAS.

F. REMOVE TRAPPED SEDIMENT AND DEBRIS FROM ALL SYSTEM COMPONENTS AFTER COMPLETION OF INSTALLATION, AND AGAIN AFTER THE ENTIRE SITE IS PERMANENTLY STABILIZED BY ESTABLISHED VEGETATION, FINISH LANDSCAPE MATERIALS, PAVED SURFACES, AND/OR ROOF AREA. REMOVE TRAPPED SEDIMENT AND DEBRIS FROM DETENTION / RETENTION BASIN BOTTOMS SO THAT FINISH BOTTOM MATERIALS / INFILTRATION FUNCTION CONFORM TO DESIGN.

3.07 LANDSCAPING

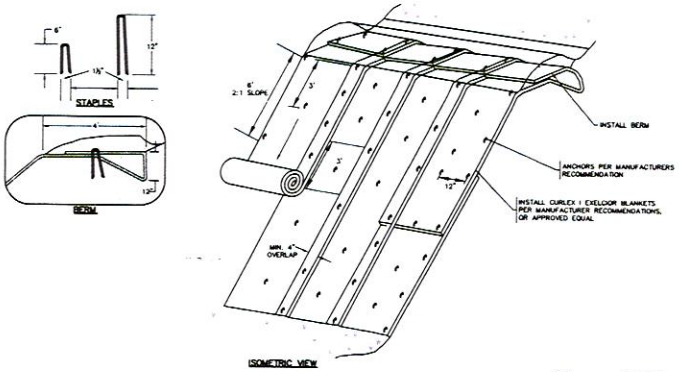
A. COMPLETE LANDSCAPING AS SOON AS POSSIBLE AFTER COMPLETION OF FINAL SUBGRADE.

B. IMMEDIATELY AFTER PLACEMENT OF PERMANENT LOAM OR TOPSOIL TO FINISHED GRADE, PERMANENTLY STABILIZE WITH CONTROL MEASURES INCLUDING, BUT NOT NECESSARILY LIMITED TO, SEED MIX, MULCH, AND / OR EROSION CONTROL BLANKETS.



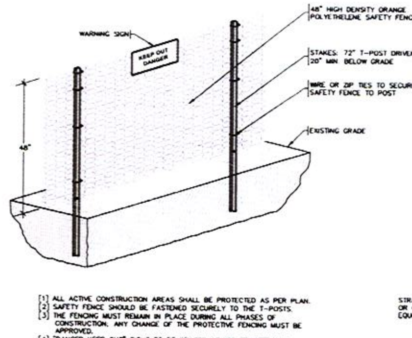
NOTES:
[1] SILT FENCE SHALL BE PLACED ALONG CONTOUR TO MAXIMIZE PONDING EFFICIENCY.
[2] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
[3] REMOVED SEDIMENT SHALL BE DEPOSITED TO A NON-SENSITIVE UPLAND AREA.

SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE



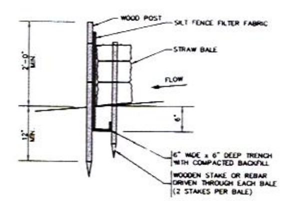
NOTES:
[1] SLOPE SURFACE SHALL BE FREE OF ROCK, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT
[2] APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS
[3] LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH
[4] MATS/BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE
[5] TAMP SOIL OVER MAT/BLANKET

TURF REINFORCEMENT MAT
NOT TO SCALE



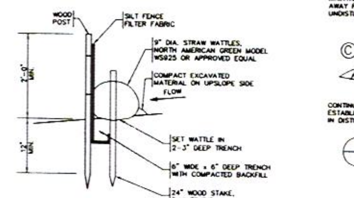
[1] ALL ACTIVE CONSTRUCTION AREAS SHALL BE PROTECTED AS PER PLAN.
[2] SAFETY FENCE SHOULD BE FASTENED SECURELY TO THE T-POSTS.
[3] THE FENCING MUST REMAIN IN PLACE DURING ALL PHASES OF CONSTRUCTION. ANY CHANGE OF THE PROTECTIVE FENCING MUST BE APPROVED.
[4] "DANGER KEEP OUT" SIGNS TO BE SPACED AT 100 FT INTERVALS.

ORANGE CONSTRUCTION SAFETY FENCE
TYPICAL CROSS SECTION
NOT TO SCALE



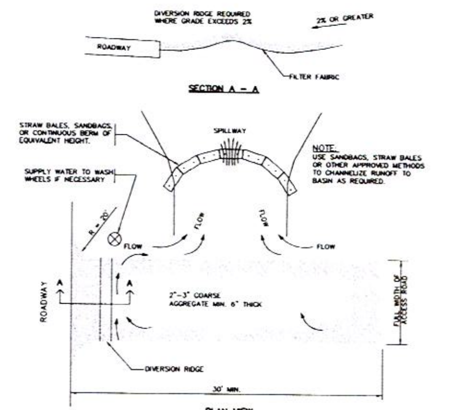
NOTES:
[1] BALES SHALL BUTT TOGETHER TO FORM A CONTINUOUS BARRIER.
[2] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY
[3] TRAPPED SEDIMENT SHALL BE REMOVED TO A NON-SENSITIVE UPLAND AREA.

STRAW BALE / SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE



NOTES:
[1] INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
[2] TRAPPED SEDIMENT SHALL BE REMOVED TO A NON-SENSITIVE UPLAND AREA.

STRAW WATTLE / SILT FENCE BARRIER
TYPICAL CROSS SECTION
NOT TO SCALE

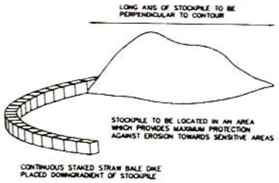


NOTES:
1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.

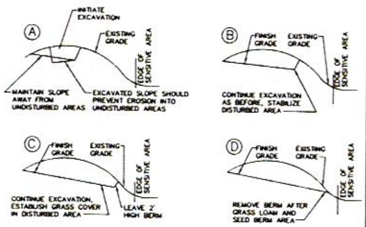
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.

3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

CONSTRUCTION ENTRANCE
NOT TO SCALE



TEMPORARY STOCKPILE
ISOMETRIC VIEW
NOT TO SCALE



EXCAVATION PROCEDURE
TYPICAL CROSS SECTION
NOT TO SCALE

DRAWING ISSUED FOR:

☐ CONCEPT ☐ CONSTRUCTION

■ PERMIT ☐ CONSTRUCTION RECORD

THIS DRAWING MAY NOT SHOW CONSTRUCTION DETAILS AND SPECIFICATIONS FOR ALL PROPOSED IMPROVEMENTS, AND MAY NOT IDENTIFY ALL CONSTRUCTION WORK ITEMS/AREAS OF CONTRACTOR JURISDICTION.

COMMONWEALTH OF MASSACHUSETTS
KYLE BURCHARD
CIVIL ENGINEER
NO. 54147
REGISTERED PROFESSIONAL ENGINEER

8/16/21

PER 250 CMR 5.03(13), THE FOLLOWING ARE EXCLUDED FROM THE PROFESSIONAL ENGINEER'S RESPONSIBILITY: ALL BOUNDARY INFORMATION; LOCATION OF EXISTING STRUCTURES, TREES, UTILITIES, TOPOGRAPHY OR SIMILAR FEATURES; DESIGN OF RETAINING WALLS, PROPRIETARY EQUIPMENT. SEE EXISTING CONDITIONS NOTE.

NO.	DATE	BY	APP	REVISION DESCRIPTION
1	8/16/2021	JFB	KFB	REVIEW COMMENTS

GPR
Engineering Solutions for Land & Structures
GOLDSMITH, PREST & RINGWALL, INC.
39 MAIN STREET, SUITE 301, AYER, MA 01432
CIVIL ENGINEERING - LAND SURVEYING - LAND PLANNING
VOICE: 978 772 1590 FAX: 978 772 1591
www.gpr-inc.com

SOLAR PHOTOVOLTAIC PROJECT

EROSION AND SEDIMENT CONTROL DETAILS

HAVERHILL SOLAR
139 AMESBURY LINE ROAD
HAVERHILL, MA

PREPARED FOR:
SOLAR SMART, LLC
1207 CONGRESSIONAL BLVD
SUMMERVILLE, SC 29483

DES. BY: JFB CHK. BY: KFB	DATE: APRIL 2021	JOB 181084	C3.4

P:\18---\181084\DWG\PERMIT\DETAIL SHTS-REV1.DWG 08-16-21 5:51:51 PM - LAYOUT C3.4 ESD

COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED

June 2, 2021

Robert Moore, Conservation Agent
Haverhill Conservation Commission
4 Summer Street, City Hall Room 300
Haverhill, MA 01830

Re: Peer Review Services
Haverhill Solar Project
139 Amesbury Line Road
Haverhill, MA

Dear Mr. Moore:

As requested by the City of Haverhill, CEI has completed a technical review of the materials and information listed below for the proposed Haverhill Solar Project at 139 Amesbury Line Road in Haverhill, MA. Our review focuses on design elements of the proposed project that pertain to the stormwater management design, based on the following information furnished to the Conservation Commission:

1. Notice of Intent Haverhill Solar Project, dated April, 2021, prepared by GPR Inc.;
2. Stormwater Management Report, dated April, 2021, prepared by GPR Inc.;
3. Site Plan Haverhill Solar Project, dated April, 2021, prepared by GPR Inc.

The proposed work includes construction of a large scale ground-mounted solar energy system, maintenance access road, walking trail, educational observation platforms and apiary with special seeding areas. The stormwater management design includes stone and grass swales with check dams, water quality swales with outlet control structures to collect and attenuate runoff, level spreaders at outlet pipes and stone diaphragms with underdrain pipes.

The project Site primarily wooded and includes two bordering vegetated wetlands (BVW) that are located along the northwest property boundary. A natural drainage divide at the Site is identified on the Site Plans with the majority of stormwater runoff flowing west, toward the wetlands and Whittier School driveway. This portion of the site is tributary to the City of Haverhill Water Supply Protection District (WSPD) for the Millvale Reservoir. Runoff from the remaining area of the Site flows to the east, toward Amesbury Line Road.

Proposed grading at the Site is limited due the nature of the proposed use and restrictions caused by shallow depth to groundwater throughout the project area. Site grading is primarily needed for construction of the maintenance road, turnaround areas and water quality swales. Proposed site work is located within the 100-foot wetland buffer area, with 14.6 acres of tree clearing outside of the 25-foot No Disturbance. A portion of the tree clearing area, between 35-feet and 75-feet, along the wetland area located on the western side of the site will not include stump removal to help maintain moisture retention and stabilize soils.

Soils at the Site are predominantly classified as HSG C, which have low infiltration rates. Soil test pit observations found shallow groundwater conditions that present a challenge for infiltrating and attenuating stormwater runoff.

CEI offers the following comments based on our review of the design drawings and NOI information listed above.

Standard 1: No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

1. Proposed check dams along the stone and grass swales should be shown in bold, black lines to better identify the locations.

2. Elevations for all stone overflows should be indicted on the plans.

3. Widths for stone emergency spillways should be labelled.

Standard 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

4. The HydroCAD model indicates post-development total runoff volume for the 2 year storm at AP1 (located at Amesbury Line Road) is greater than the pre-development volume. The Subcatchment (P2) area for AP1 includes the access driveway from Amesbury Line Road to the Vehicular Turnaround Area #1, wooded land to the northeast of the driveway, Water Quality Swale #4 (WQS4) and a Stone Diaphragm (a stone trench with an underdrain pipe).

   The stormwater runoff from Subcatchment P2 is primarily collected by a swale on the north side of the access driveway and turnaround area, conveyed to WQS4 and discharged through an outlet control structure which then discharges to the Stone Diaphragm between the north edge of the driveway and abutting property (Lot 430-11-2A). The drainage system is designed to infiltrate runoff in WQS4 and the Stone Diaphragm. Promoting infiltration in this area may cause groundwater levels to rise above existing conditions during storm events and potentially impact abutting properties and existing on-site septic systems.

   CEI recommends completing additional stormwater and groundwater evaluations, such as a mounding analysis and soil test pits, to better assess potential impacts to abutting properties. The Applicant's Engineer may also want to consider reducing stormwater flow toward Amesbury Line Road by grading the turnaround area to convey runoff to the west of the access driveway.

5. HydroCAD analysis points should be located at each of the school driveway culvert crossings to better isolate and compare each wetland drainage area under pre and post-development conditions.

Standard 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures.

6. Calculations were provided to demonstrate the proposed Water Quality Swales are designed to provide infiltration for required recharge volumes below low flow orifices. The bottom elevations at Water Quality Swales 2, 3 and 4 do not appear to maintain a minimum 2-foot separation to estimated high groundwater elevations. The Applicant's Engineer may consider maintaining the existing grades at each water quality swale to establish a bottom elevation that would provide a 2-foot separation to groundwater.

7. Backup calculations should be provided to demonstrate all BMPs designed to provide stormwater storage completely drain within 72 hours. Calculations should include the grass swales that are proposed along the slopes leading down to the Water Quality Swales.

    a. Consideration should be given to the potential for swales located on the upper slope to influence the groundwater elevation and dewatering capabilities of the swales located toward the bottom of the slope.

    Construction of the grassed swales require a cut in the slope to form the swale which will further reduce depth to groundwater.

8. The City of Haverhill WSPD Ordinance (Section 9.2.9.4) includes a design standard that requires all increase in runoff generated on the site shall be recharged on-site in a manner demonstrated to assure full protection of the water quality and quantity in the WSPD". CEI recommends the City of Haverhill make a determination on the proposed drainage design for compliance with this design standard.

Standard 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

The proposed stormwater management design provides the required TSS removal.

Standard 5: For Land Uses with Higher Potential Pollutant Loads (LUHPPL), source control and pollution prevention shall be implemented.

The proposed project does not meet thresholds or characteristics of a LUHPPL.

Standard 6: Stormwater discharges near or to any critical area require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices.

The proposed stormwater management system includes four discharge locations within the WSPD. Each location is located outside of the 25-foot No Disturbance zone and includes upstream BMPs that provide suitable treatment for managing discharges. The proposed land use does not appear to include equipment or activities that would pose a threat for an emergency spill or unexpected event which would require shutdown or containment.

Standard 7: Redevelopments projects are required to meet the Massachusetts Stormwater Management Standards only to the maximum extent practicable.

This project is not considered a redevelopment.

Standard 8: A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities.

9. A Turf Reinforcement Mat detail is included on the plans but the proposed installation areas are not shown. Plans should include labels and shaded areas where the Mat is being proposed.

10. The Construction Entrance detail should be revised to require a minimum length of 50 feet.

11. Catch basin inlet protection should be required for all proposed catch basins during the construction period and removed once the site has been fully stabilized.

12. Erosion and Sediment Control Notes (Sheet C3.4) should include silt sock installation, inspection and maintenance notes.

13. Erosion and Sediment Control should include inspection requirements with minimum weekly inspections and after every ½" storm event.

14. The Applicant has acknowledged a SWPPP will be submitted as part of the NPDES Construction General Permit filing with EPA. The site owner and the contractor are each

considered "operators" under that permit, and each will need to file an EPA Notice of Intent for coverage under that permit. Prior to filing a Notice of Intent, the applicant and its contractor must prepare a Stormwater Pollution Plan (SWPPP).

a. The Applicant shall provide the Conservation Commission with a copy of the SWPPP before land disturbance commences.

b. The Applicant shall provide the Commission with evidence that all "operators" (as defined in the NPDES Construction General Permit) have filed for coverage under the permit.

The Applicant shall obtain authorization from the Conservation Commission or its agent prior to filing a Notice of Termination under the EPA permit.

15. A phased Construction Plan is recommended to limit the area of disturbance, especially within the WSPD. Proposed water quality swales, outlet control structures and drainage swales should be stabilized and prepared to contain potential sediment runoff from upstream phased areas during the construction period. Any sediment that is collected in the BMPs shall be removed upon completion of work and re-stabilized as needed.

Standard 9: A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

The Applicant has provided an Operation and Maintenance Plan for the Site and associated stormwater BMPs that are included in the facility design.

16. Designated snow storage and disposal requirements should be added in the O&M Plan and areas should be identified on the BMP Locus Plan.

17. Access driveway maintenance should be added in the O&M Plan to include requirements for regrading or repairing the gravel surface in order to maintain grading and properly convey runoff without causing channeling or erosion of slopes and drainage swales.

18. Long-term water resource pollution prevention strategies should strongly prohibit herbicide, pesticide and fertilizer application in any area of the property.

Standard 10: All illicit discharges to the stormwater management system are prohibited.

The Applicant has acknowledged an Illicit Discharge Compliance Statement is required and will be submitted prior to the discharge of any stormwater to post-construction BMPs.

General Comments:

19. Inspection and maintenance access ports should be included for all level spreader and underdrain pipes. Access ports should be indicated on the plans and details at both ends of each pipe.

20. Outlet Control Structures should include screens or cages for each orifice to help prevent clogging.

21. Typical Detail of the Solar Field Array Racking System should provide information for the proposed surface (i.e. grass) beneath the rows of panels and specifically alone the drip line.

22. Proposed check dams and stone overflow weirs should be shown as black, bold line type to better identify the proposed locations.

23. Spot elevations at each stone overflow weir should be labelled.

24. Design plans indicates a 195' stone diaphragm with a 6" underdrain pipe is proposed. The HydroCAD model includes a 100' long trench with an 8" underdrain pipe. Plans and model should be revised and consistent.

25. Staging area and stock pile locations are needed on the Erosion and Sediment Control Plan.

26. All proposed catch basins should require silt sack installation during the construction period. A silt sack detail should be added to the plans.

27. A proposed 22 foot wide access driveway may be excessive for the intended use. Decreasing the driveway width and replacing it with additional vegetated cover would help reduce stormwater runoff.

If you have any questions or comments regarding this report, please contact me at 508-281-5160.

Sincerely,

COMPREHENSIVE ENVIRONMENTAL, INC.

Curt Busto
Project Engineer

LEGAL DESCRIPTION OF PROPERTY

~~thmdmxbdx~~ A certain parcel of land, in Haverhill, Mass., located on the Southerly side of Amesbury Line Road, beginning at the Northeasterly corner thereof, at land of Richard Mackinion, thence running

S 74°-14'-50" W 523.81'	along land of Mackinion and land of Henry Duchemin, along a stonewall, to a point, thence
S 74°-48'-11" W 194.48'	along land of Henry Duchemin, and along a stone wall, to a point, thence
S 74°-16'-35" W 276.18'	along land of Henry Duchemin, and along a stone wall, to a point, thence
S 35°-20'-48" E 123.49'	along land of Henry Duchemin, and along a stone wall, to a point, thence
S 36°-22'-52" E 296.04'	along land of Henry Duchemin, to an iron pipe at land of George Kimball, thence
S 67°-52'-39" W 379.62'	along land of George Kimball, along a stone wall, to a point thence
S 66°-56'-38" W 203.83'	along land of George Kimball, along a stone wall, to an iron pipe, at the land of the Whittier Regional Vocational Technical High School, thence
S 58°-14'-52" W 246.96'	along land of the Whittier Regional Vocational Technical High School, along a stonewall, to a point, thence
S 58°-11'-56" W 162.71'	along land of the Whittier Regional Vocational Technical High School, along a stonewall, to a point, thence
N 31°-47'-34" W 594.67'	along land of the Whittier Regional Vocational High School, to an iron rod at a stonewall, thence,
N 24°-13'-18" W 160.10'	along land of the Whittier Regional Vocational Technical High School, along a stonewall, to an iron rod, thence
N 55°-42'-40" E 372.50'	along land of the Whittier Regional Vocational Technical High School, to a point, thence
N 74°-24'-56" E 831.89'	along land of the Whittier Regional Vocational Technical High School, to a point, thence
N 27°-47'-36" E 337.71'	along land of the Whittier Regional Vocational Technical High School, to an iron pipe, thence
N 15°-20'-04" W 245.67'	along land of the Whittier Regional Vocational Technical High School, to an iron pipe, thence
N 09°-33'-06" E 198.32'	to a point at Amesbury Line Road, thence
S 54°-51'-26" E 105.49'	along Amesbury Line Road to a point, thence
S 54°-55'-26" E 153.70'	along Amesbury Line Road to a point, thence
S 53°-52'-44" E 60.90'	along Amesbury Line Road to a point, thence
S 57°-37'-52" E 82.76'	along Amesbury Line Road to a point, thence
S 60°-39'-23" E 74.49'	along Amesbury Line Road to a point, thence
S 51°-01'-34" E 98.07'	along Amesbury Line Road to a point at land of Melvin Nelson, thence
S 27°-40'-10" E 116.10'	along land of Melvin Nelson to a point, thence
S 14°-47'-35" E 387.48'	along land of Melvin Nelson to a point, thence
N 74°-14'-50" E 219.00'	along land of Melvin Nelson to a point at Amesbury Line Road, thence
S 30°-10'-10" E 28.91'	along Amesbury Line Road, to a stonewall, at land of Richard MacKinion, being the point of beginning.

Said parcel contains 26.813 Acres, and is subject to a 28' wide utility easement shown in more detail on the plan referenced below, and said parcel is subject to the benefit of a right-of-way to pass and repass over land of the Whittier Regional Vocational Technical High School, as shown on the referenced plan, and as noted in Book 5686, Page 428 in the Essex South District Registry of Deeds. Said parcel is more particularly shown on a "Plan of Land in Haverhill, Mass., drawn for Theodore Xenakis, December 1981, scale 1"=80', Merrimack Engineering Services, 66 Park Street, Andover, Mass".

For my title see deed recorded with Essex South District Registry of Deeds at
Book 15605 , Page 19

NOTICE OF LEASE

LANDLORD:	Theodore Xenakis 139 Amesbury Line Road Haverhill, Massachusetts 01830
TENANT:	Solar Smart, LLC 1605 Central Avenue STE 6, #255 Summerville, South Carolina 29483
PREMISES:	139 Amesbury Line Road Haverhill, Massachusetts 01830
TERM:	, 2021 through , 2046
OPTIONS TO EXTEND:	The lease also provides the Tenant with the option to extend the lease for up to two (2) five (5) year extensions
Date of Lease:	, 2021

EXECUTED as a SEALED INSTRUMENT this 24th **day of** March **, 2021**

Deborah A Conner
Witness

Theodore Xenakis- Landlord

Solar Smart, LLC

Witness

Peter Rundle, CEO- Tenant

COMMONWEALTH OF MASSACHUSETTS

Essex, ss. March 24, 2021

On this 24th day of March, 2021, before me the undersigned notary public, personally appeared the above named Theodore Xenakis, as aforesaid, proved to me through satisfactory evidence of identification, which was a valid driver's license with photographic identification, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose.

Deborah A Conner

Notary Public
My Commission Expires: 6/28/2024

DEBORAH A. CONNER
NOTARY PUBLIC
Commonwealth of Massachusetts
My Commission Expires
June 28, 2024

COMMONWEALTH OF SOUTH CAROLINA

Essex, ss. March 24, 2021

On this 24 day of March, 2021, before me the undersigned notary public, personally appeared the above named Peter Rundle, as aforesaid, proved to me through satisfactory evidence of identification, which was a valid driver's license with photographic identification, which was SCDL 101505149, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily on behalf of Solar Smart, LLC for its stated purpose as Tenant.

Witness my hand and official seal:

JACKSON GILBERT
Notary Public, State of SC
County of Dorchester
My Comm Exp 08/19/2030

Notary Public
My Commission Expires:

Theodore Xenakis

Attorney at Law

139 Amesbury Line Road ***(978) 373-5493***

Haverhill, MA 01830

Xenakislawoffice@gmail.com

March 31, 2021

Haverhill City Council
City Hall Building
Room 204
4 Summer Street
Haverhill, MA 01830

Re: 139 Amesbury Line Road Solar Farm
Application for Solar Use Special Permit (§7.8.11) and
Application for Water Supply Protection District (WSPD) Special Permit (§9.2.7)

Dear City Council Members:

Please be advised that as owner of the real estate located at 139 Amesbury Line Road, Haverhill, Massachusetts 01830, I hereby give my consent to the above referenced applications by Solar Smart, LLC, the Applicant and Lessee.

I respectfully request that the aforesaid applications be granted.

Thank you for your kind consideration.

Sincerely yours,

Theodore Xenakis, Esquire

TX/bpm

Applicant Responses To City Department Comments

2021.04.14
LINDA KOUTOULAS commented on City Clerk Review - Hearing Dates Set for #CCSP-21-8

"Hearing scheduled for Jun 15"
RESPONSE: We have sought continuances as appropriate. Thank you for your response.
2021.05.12
John D'Aoust commented on Water Supply Review for #CCSP-21-9

"The Haverhill Water Department (HWD) has reviewed the proposed solar facility finds that the proposed use is not a prohibited under Chapter 255 Sec 9.2.6. The site storm water management plan and facility O&M plan have been reviewed and do not present any concerns in terms of water supply protection as all proposed activities are outside the delineated Zone A for surface water protection.

The Facility O&M does list a preventative activity related to sampling of transformer fluids. The HWD was unable to determine if any of the proposed equipment that contained hazardous liquids such as transformers and batteries were protected from accidental release with containment areas. The HWD recommends that the applicant describe what type of hazardous liquids or other materials may be in use on the site and how protective measures will be applied to prevent accidental releases."

RESPONSE: Electric transformers shall use Envirotemp™ 360 or FR3 fluid, which have the same general chemical composition as vegetable oil. Considered substantially inert to the environment, no secondary containment is proposed. MSDS are included in Appendix 1 of the AMENDED City Council Special Permit Application.

The proposed battery enclosures have a triple redundancy protection against failures. The modes of protection consist of:

1. **The connex box itself is a sealed steel enclosure affixed to a concrete pad. The batteries are located inside the steel enclosure, protected from weather exposure.**
2. **An integrated cooling system and thermostat keeps the batteries from overheating.**
3. **The enclosure is equipped with a "FM-200™ Clean Agent Fire Suppression System" using the cleanest fire suppression technology available. A material safety data sheet for the active chemical, HFC-227ea is included in Appendix 1.**

Should the cooling system fail, and the fire extinguishing system fail, any combustion of materials inside the steel connex container remains inside the container.

2021.05.18
Michael Picard commented on Fire2 Department Review for #CCSP-21-8 & #CCSP-21-9

"The planning, design and construction of new buildings, renovation of existing buildings and structures to provide egress facilities, fire protection and built-in fire protection equipment shall be in accordance with 780 CMR; and any alterations, additions or changes in buildings required by the provisions of 527 CMR which in the scope of 780 CMR, 9th edition, shall be made in accordance therewith. (527 CMR 1.04(4) and 780 CMR 101.2). Additionally, 780 CMR (901.2.1) Document Submittal Process will be required.

Plans approved by the fire department are approved with the intent they comply in all respects to MSBC, 780 CMR 527 CMR 1.00, MGL Chapter 148 and any City of Haverhill ordinance. Any omissions or errors on the plans do not relieve the applicant of complying with applicable requirements.

Project must comply with the City of Haverhill rules and regulations regarding zoning for solar fields

Required on site plan:
Fire Department access
Turnarounds
Road width
Grade of road

Special considerations:

Battery storage location
Suppression system for battery storage location Permitted
Remote shutoff locations
Key boxes
Emergency contact information"
RESPONSE: Fire Department access, turnarounds, road width and grades of the road are depicted on the Site Plan sheets. An Amended One-Line Diagram depicting the features of the electrical system is in Appendix 5, and considerations for final placements of all shutoff locations, key boxes, and emergency contact information shall be provided to the satisfaction of the City of Haverhill Fire Department on final electrical engineering drawings. Thank you for your response.

2021.05.20
Mark Tolman commented on Health Department Review for #CCSP-21-8

"No BOH approvals required."
2021.06.08
RESPONSE: We acknowledge your response. Thank you for your response.

Mark Tolman commented on Health Department Review for #CCSP-21-9
"BOH has no concern at this time."
RESPONSE: We acknowledge your response. Thank you for your response.

2021.05.27
Paul Jessel commented on Wastewater Review for #CCSP-21-9

"
City sewerage is not available
"

RESPONSE: We acknowledge your response, and no sewerage service is proposed or requested. Thank you for your response.

2021.06.01

John D'Aoust commented on Water Supply Review for #CCSP-21-8

"The Haverhill Water Department (HWD) has reviewed the provided information and finds that the proposed use is not prohibited by Chapter 255 Sec 9.2.6 of the City's zoning code. The proposed project lies in the public water supply watershed for the Millvale Reservoir. As indicated on the submitted plans the proposed work onsite is outside of the delineated water supply protection zone A.

The HWD reviewed the proposed facility storm water management and operations and maintenance plans. It is noted in the operations and maintenance plan that there is a maintenance item related to transformer fluids. It is unclear how the proposed facility will provide protection from an accidental release of hazardous fluids or liquids from transformers, batteries, or other equipment that may be used at the site. The HWD recommends that the applicant describe to what extent there may be hazardous fluids, liquids, or other materials used on the site and what means will be taken to prevent an accidental release. "

RESPONSE: Electric transformers shall use Envirotemp™ 360 or FR3 fluid, which have the same general chemical composition as vegetable oil. Considered substantially inert to the environment, no secondary containment is proposed. MSDS are included in Appendix 1 of the AMENDED City Council Special Permit Application.

The proposed battery enclosures have a triple redundancy protection against failures. The modes of protection consist of:

1. The connex box itself is a sealed steel enclosure affixed to a concrete pad. The batteries are located inside the steel enclosure, protected from weather exposure.
2. An integrated cooling system and thermostat keeps the batteries from overheating.
3. The enclosure is equipped with a "FM-200™ Clean Agent Fire Suppression System" using the cleanest fire suppression technology available. A material safety data sheet for the active chemical, HFC-227ea is included in Appendix 1.

Should the cooling system fail, and the fire extinguishing system fail, any combustion of materials inside the steel connex container remains inside the container.

2021.06.01
Glenn Smith commented on Water Department Review for #CCSP-21-8 & #CCSP-21-9

"There is NO WATER INFRASTRUCTURE proposed for this project. The Water Distribution Division has NO COMMENT at this time."
RESPONSE: We acknowledge your response. Thank you for your response.

2021.06.07
Robert Ward commented on Wastewater Review for #CCSP-21-8

"The proposed solar energy facility does not require a sewer connection."
RESPONSE: This comment is accurate. No sewer connection is needed. Thank you for your response.

2021.06.11
Robert Moore commented on Storm Water Review for #CCSP-21-9

"Applicant has filed a Notice of Intent application with the Conservation Commission. The hearing is currently ongoing. The next scheduled date for hearing discussion is June 24th. To date, concerns with the wetland boundaries represented on the plan have been identified. Additional concerns, pertaining to the stormwater management design, have also be identified through the Commission's peer review process. A copy of the initial stormwater peer review letter will be uploaded to this record for the Council. The applicant's consultants continue to work with the Commission to resolved the identified concerns."
RESPONSE: Peer Review comments have been addressed and updated plans and reports provided for second review. Thank you for your response.

2021.07.07
Robert Ward commented on Water Department Review for #CCSP-21-8

"The project solar array which does not require water."
Robert Ward commented on Water Department Review for #CCSP-21-8
RESPONSE: We acknowledge your response, and this is correct. Thank you for your response.

"The Water Department does not object to approval of a special permit for this project."
RESPONSE: Thank you for your response.

Kyle Burchard

From: Lieutenant Michael Picard <MPicard@haverhillfire.com>
Sent: July 22, 2021 3:16 PM
To: Kyle Burchard
Subject: Re: External Message Solar Smart Fire Lane Proposal

Hello,
After the Fire Department review of the lower road surface at 139 Amesbury Line Road, it was determined that the Fire Department will accept the proposal for the system listed. GRASSPAVE2 or equivalent, if it can support a Fire Department Engine at 39,620 pounds.

Lt. Michael Picard
Haverhill Fire Department
Fire Prevention / Investigation Unit
Tel: 978-373-8460
Fax: 978- 521- 4441
Email: mpicard@haverhillfire.com

From: Kyle Burchard <KBurchard@gpr-inc.com>
Sent: Friday, July 16, 2021 5:23 PM
To: Lieutenant Michael Picard <MPicard@haverhillfire.com>; Deputy Chief Eric Tarpy <ETarpy@haverhillfire.com>
Subject: External Message Solar Smart Fire Lane Proposal

Good afternoon.

Several weeks ago I had discussed with both of you at different times an alternative treatment of the proposed driveway entrance to the solar farm proposed at 139 Amesbury Line Road by Solar Smart LLC on the land of Ted Xenakis. I was supposed to send the attached proposal back then also, but resolving various other engineering issues needed to come first.

Please review the attached proposal letter, drawings and documents for the treatment of the initial part of the fire lane from Amesbury Line Road, and let me know if you have questions.
I hope that the proposal is acceptable to the Fire Department for this unique access for the reasons stated within, or that we can resolve any concerns that you have.

Have a good weekend and I look forward to speaking with you next week.
Thank you.

Kyle Burchard, P.E.
Goldsmith, Prest & Ringwall, Inc.
39 Main Street, Suite 301, Ayer, MA 01432
T 978-772-1590 F 978-772-1591
Licensed in MA,ME,NH & VA
GPR Engineering Solutions for Land & Structures
www.gpr-inc.com

ParcelID	StreetNum	StreetName	LocCity	Owner1	BillingAddress	City	State	Zip
430-1-10	114	AMESBURY LINE RD	HAVERHILL	FEENSTRA BRAD MICHAEL-ETAL	114 AMESBURY LINE ROAD	HAVERHILL	MA	1830
430-1-7	120	AMESBURY LINE RD	HAVERHILL	FAY JAMES M	120 AMESBURY LINE RD	HAVERHILL	MA	1830
430-1-7A		AMESBURY LINE RD	HAVERHILL	WHITTIER REGIONAL HIGH SCH	115 AMESBURY LINE RD	HAVERHILL	MA	1830
430-1-7B	220	AMESBURY LINE RD	HAVERHILL	LeBLANC-MEDEIROS MOLLY K-ETALI	9 VALLEY ST	MERRIMAC	MA	1860
430-1-8	180	AMESBURY LINE RD	HAVERHILL	BINKS JOSEPH A	180 AMESBURY LINE RD	HAVERHILL	MA	1830
430-1-8A	178	AMESBURY LINE RD	HAVERHILL	ANDREOTTOLA MICHAEL D	178 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-1	235	AMESBURY LINE RD	HAVERHILL	DUCHEMIN MICHEL MARIE-ETAL	235 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-12	139	AMESBURY LINE RD	HAVERHILL	XENAKIS THEODORE	139 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-17	189	AMESBURY LINE RD	HAVERHILL	BOUCHER GERARD	189 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-17-2		AMESBURY LINE RD	HAVERHILL	BOUCHER DAVID P ETAL	189 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-17-3		AMESBURY LINE RD	HAVERHILL	BOUCHER DAVID P ETAL	189 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-18A	115	AMESBURY LINE RD	HAVERHILL	WHITTIER REGIONAL HIGH SCH	115 AMESBURY LINE RD	HAVERHILL	MA	1830
430-11-2	205	AMESBURY LINE RD	HAVERHILL	YACUBACCI DANIEL J	205 AMESBURY LINE RD	HAVERHILL	MA	01830-1732
430-11-2A	199	AMESBURY LINE RD	HAVERHILL	PEPE WILLIAM C	32 GREENLEAF ST	BRADFORD	MA	1835
430-11-3	217	AMESBURY LINE RD	HAVERHILL	LOWES DWIGHT W ETUX	217 AMESBURY LINE RD	HAVERHILL	MA	1830
460-1-7		EAST BROADWAY	HAVERHILL	JUDITH KIMBALL FARM, LLC	272 NORTH EAST POND RD	MILTON	NH	3851

CCSP-21- 8, 9

430-1-10
FEENSTRA BRAD MICHAEL-ETAL
114 AMESBURY LINE ROAD
HAVERHILL, MA 01830

430-1-7
FAY JAMES M
120 AMESBURY LINE RD
HAVERHILL, MA 01830

430-1-7A
WHITTIER REGIONAL HIGH SCH
115 AMESBURY LINE RD
HAVERHILL, MA 01830

430-1-7B
LeBLANC-MEDEIROS MOLLY K-ETALI
9 VALLEY ST
MERRIMAC, MA 01860

430-1-8
BINKS JOSEPH A
180 AMESBURY LINE RD
HAVERHILL, MA 01830

430-1-8A
ANDREOTTOLA MICHAEL D
178 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-1
DUCHEMIN MICHEL MARIE-ETAL
235 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-12
XENAKIS THEODORE
139 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-17
BOUCHER GERARD
189 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-17-2
BOUCHER DAVID P ETAL
189 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-17-3
BOUCHER DAVID P ETAL
189 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-18A
WHITTIER REGIONAL HIGH SCH
115 AMESBURY LINE RD
HAVERHILL, MA 01830

430-11-2
YACUBACCI DANIEL J
205 AMESBURY LINE RD
HAVERHILL, MA 01830-1732

430-11-2A
PEPE WILLIAM C
32 GREENLEAF ST
BRADFORD, MA 01835

430-11-3
LOWES DWIGHT W ETUX
217 AMESBURY LINE RD
HAVERHILL, MA 01830

460-1-7
JUDITH KIMBALL FARM, LLC
272 NORTH EAST POND RD
MILTON, NH 03851

TO: Whom It May Concern June 5, 2021

RE: Honey Bee colony installations on land to be leased by POWERFACTOR Company off Amesbury Line Road,Haverhill,MA (Theodore Xenakis,owner)

Dear Sirs/Madams:

Please be advised that I am developing a partnership with representatives of POWERFACTOR Company, to install an environmentally-friendly system of beehives on the above-noted property. I will be working directly with a professional full-time beekeeper from West Peabody,MA as well ,in order to set-up the hives in the most ergonomically/aesthetically- efficient manner for this property. It is my understanding that POWERFACTOR Company will coordinate wildflower plots in conjunction with suitable vegetation for the hives which should thrive as a result. Management of the hives will occur on a regular basis by myself and/or other beekeepers for the duration of the projected solar project.

As most know, honey bee pollination is essential for the growth of most local fruits and vegetables which we all consume. The proposed solar location is adjacent to several Haverhill farms, as well as numerous homes and waterways. This project should provide an inspiration for beautification of rural properties in Haverhill , and could provide a future site for school children educational projects as well!

Once established, it would be my pleasure to personally accommodate any Councilors who may be interested in viewing the beehive/solar project. Perhaps a jar of honey for sampling could be an enticement as well?

Respectfully,

Dr.Sam Amari, Jr

Haverhill, MA 978-373-9330

City of Haverhill, MA

08/18/2021

CCSP-21-9

Wastewater Review

City Council Special Permit

Status: Complete

Assignee: Paul Jessel

Became Active: 05/18/2021

Completed: 05/27/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Paul Jessel, May 27, 2021 at 10:29am
City sewerage is not available

City of Haverhill, MA

08/18/2021

CCSP-21-9

Water Supply Review

City Council Special Permit

Status: Complete

Assignee: John D'Aoust

Became Active: 05/18/2021

Completed: 05/27/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

John D'Aoust, May 13, 2021 at 7:06am

The Haverhill Water Department (HWD) has reviewed the provided information and finds that the proposed use is not prohibited by Chapter 255 Sec 9.2.6 of the City's zoning code. The proposed project lies in the public water supply watershed for the Millvale Reservoir. As indicated on the submitted plans the proposed work onsite is outside of the delineated water supply protection zone A.

The HWD reviewed the proposed facility storm water management and operations and maintenance plans. It is noted in the operations and maintenance plan that there is a maintenance item related to transformer fluids. It is unclear how the proposed facility will provide protection from an accidental release of hazardous fluids or liquids from transformers, batteries, or other equipment that may be used at the site. The HWD recommends that the applicant describe to what extent there may be hazardous fluids, liquids, or other materials used on the site and what means will be taken to prevent an accidental release.

City of Haverhill, MA

08/18/2021

CCSP-21-9

Water Department Review

City Council Special Permit

Status: Complete

Assignee: Glenn Smith

Became Active: 05/18/2021

Completed: 06/01/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Glenn Smith, Jun 1, 2021 at 4:41pm

There is NO WATER INFRASTRUCTURE proposed for this project. The Water Distribution Division has NO COMMENT at this time.

City of Haverhill, MA

08/18/2021

CCSP-21-9

Conservation Department Review

City Council Special Permit

Status: Complete

Assignee: Robert Moore

Became Active: 05/18/2021

Completed: 06/11/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Robert Moore, Jun 11, 2021 at 12:47pm

Applicant has filed a Notice of Intent application with the Conservation Commission. The hearing is currently ongoing. The next scheduled date for hearing discussion is June 24th. To date, concerns with the wetland boundaries represented on the plan have been identified. Additional concerns, pertaining to the stormwater management design, have also be identified through the Commission's peer review process. A copy of the initial stormwater peer review letter will be uploaded to this record for the Council. The applicant's consultants continue to work with the Commission to resolved the identified concerns.

City of Haverhill, MA

08/18/2021

CCSP-21-9

Storm Water Review

City Council Special Permit

Status: Complete

Assignee: Robert Moore

Became Active: 05/18/2021

Completed: 06/11/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Robert Moore, Jun 11, 2021 at 12:47pm

Applicant has filed a Notice of Intent application with the Conservation Commission. The hearing is currently ongoing. The next scheduled date for hearing discussion is June 24th. To date, concerns with the wetland boundaries represented on the plan have been identified. Additional concerns, pertaining to the stormwater management design, have also be identified through the Commission's peer review process. A copy of the initial stormwater peer review letter will be uploaded to this record for the Council. The applicant's consultants continue to work with the Commission to resolved the identified concerns.

City of Haverhill, MA

08/18/2021

CCSP-21-9

Planning Director Approval for Agenda

City Council Special Permit

Status: Pending

Assignee: William Pillsbury

Became Active:

Completed:

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

William Pillsbury, Jun 10, 2021 at 12:31pm

Recommend approval of the two requested special permits as presented

City of Haverhill, MA

08/18/2021

CCSP-21-9

Fire2 Department Review

City Council Special Permit

Status: Complete

Assignee: Michael Picard

Became Active: 05/18/2021

Completed: 05/18/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Michael Picard, May 18, 2021 at 4:27pm

The planning, design and construction of new buildings, renovation of existing buildings and structures to provide egress facilities, fire protection and built-in fire protection equipment shall be in accordance with 780 CMR; and any alterations, additions or changes in buildings required by the provisions of 527 CMR which in the scope of 780 CMR, 9th edition, shall be made in accordance therewith. (527 CMR 1.04(4) and 780 CMR 101.2). Additionally, 780 CMR (901.2.1) Document Submittal Process will be required.

Plans approved by the fire department are approved with the intent they comply in all respects to MSBC, 780 CMR 527 CMR 1.00, MGL Chapter 148 and any City of Haverhill ordinance. Any omissions or errors on the plans do not relieve the applicant of complying with applicable requirements.

Project must comply with the City of Haverhill rules and regulations regarding zoning for solar fields

Required on site plan:

Fire Department access
Turnarounds

Road width
Grade of road

Special considerations:

Battery storage location
Suppression system for battery storage location Permitted
Remote shutoff locations
Key boxes
Emergency contact information

City of Haverhill, MA

08/18/2021

CCSP-21-8

Building Inspector Review

City Council Special Permit

Status: Complete

Assignee: Tom Bridgewater

Became Active: 04/13/2021

Completed: 05/09/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Tom Bridgewater, May 9, 2021 at 8:48pm

This project will meet all zoning requirements,after reviewing I concur with the zoning opinion. This project went thru a PPR review before submitting to CC

City of Haverhill, MA

08/18/2021

CCSP-21-8

Fire2 Department Review

City Council Special Permit

Status: Complete

Assignee: Michael Picard

Became Active: 05/18/2021

Completed: 05/18/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Michael Picard, May 18, 2021 at 12:14pm

The planning, design and construction of new buildings, renovation of existing buildings and structures to provide egress facilities, fire protection and built-in fire protection equipment shall be in accordance with 780 CMR; and any alterations, additions or changes in buildings required by the provisions of 527 CMR which in the scope of 780 CMR, 9th edition, shall be made in accordance therewith. (527 CMR 1.04(4) and 780 CMR 101.2). Additionally, 780 CMR (901.2.1) Document Submittal Process will be required.

Plans approved by the fire department are approved with the intent they comply in all respects to MSBC, 780 CMR 527 CMR 1.00, MGL Chapter 148 and any City of Haverhill ordinance. Any omissions or errors on the plans do not relieve the applicant of complying with applicable requirements.

Project must comply with the City of Haverhill rules and regulations regarding zoning for solar fields

Required on site plan:
Fire Department access
Turnarounds
Road width

Grade of road

Special considerations:

Battery storage location
Suppression system for battery storage location Permitted
Remote shutoff locations
Key boxes
Emergency contact information

City of Haverhill, MA

08/18/2021

CCSP-21-8

Water Department Review

City Council Special Permit

Status: Complete

Assignee: Robert Ward

Became Active: 05/18/2021

Completed: 06/07/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Glenn Smith, Jun 1, 2021 at 4:32pm

There is NO WATER INFRASTRUCTURE proposed for this project. The Water Distribution Division has NO COMMENTS at this time.

Robert Ward, Jul 7, 2021 at 3:29pm

The Water Department does not object to approval of a special permit for this project.

City of Haverhill, MA

08/18/2021

CCSP-21-8

Wastewater Review

City Council Special Permit

Status: Complete

Assignee: Robert Ward

Became Active: 05/18/2021

Completed: 06/07/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Robert Ward, Jun 7, 2021 at 12:28pm

The proposed solar energy facility does not require a sewer connection.

City of Haverhill, MA

08/18/2021

CCSP-21-8

Conservation Department Review

City Council Special Permit

Status: Complete

Assignee: Robert Moore

Became Active: 05/18/2021

Completed: 06/11/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Robert Moore, Jun 11, 2021 at 12:45pm

Applicant has filed a Notice of Intent application with the Conservation Commission. The hearing is currently ongoing. The next scheduled date for hearing discussion is June 24th. To date, concerns with the wetland boundaries represented on the plan have been identified. Additional concerns, pertaining to the stormwater management design, have also be identified through the Commission's peer review process. A copy of the initial stormwater peer review letter will be uploaded to this record for the Council. The applicant's consultants continue to work with the Commission to resolved the identified concerns.

City of Haverhill, MA

08/18/2021

CCSP-21-8

Storm Water Review

City Council Special Permit

Status: Complete

Assignee: Robert Moore

Became Active: 05/18/2021

Completed: 06/11/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

Robert Moore, Jun 11, 2021 at 12:45pm

Applicant has filed a Notice of Intent application with the Conservation Commission. The hearing is currently ongoing. The next scheduled date for hearing discussion is June 24th. To date, concerns with the wetland boundaries represented on the plan have been identified. Additional concerns, pertaining to the stormwater management design, have also be identified through the Commission's peer review process. A copy of the initial stormwater peer review letter will be uploaded to this record for the Council. The applicant's consultants continue to work with the Commission to resolved the identified concerns.

City of Haverhill, MA

08/18/2021

CCSP-21-8

Water Supply Review

City Council Special Permit

Status: Complete

Assignee: Robert Ward

Became Active: 05/18/2021

Completed: 06/11/2021

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA
01830

Comments

John D'Aoust, Jun 1, 2021 at 2:54pm

The Haverhill Water Department (HWD) has reviewed the provided information and finds that the proposed use is not prohibited by Chapter 255 Sec 9.2.6 of the City's zoning code. The proposed project lies in the public water supply watershed for the Millvale Reservoir. As indicated on the submitted plans the proposed work onsite is outside of the delineated water supply protection zone A.

The HWD reviewed the proposed facility storm water management and operations and maintenance plans. It is noted in the operations and maintenance plan that there is a maintenance item related to transformer fluids. It is unclear how the proposed facility will provide protection from an accidental release of hazardous fluids or liquids from transformers, batteries, or other equipment that may be used at the site. The HWD recommends that the applicant describe to what extent there may be hazardous fluids, liquids, or other materials used on the site and what means will be taken to prevent an accidental release.

City of Haverhill, MA

08/18/2021

CCSP-21-8

Planning Director Approval for Agenda

City Council Special Permit

Status: Pending

Assignee: William Pillsbury

Became Active:

Completed:

Applicant

Robert Harb
bobharb@aol.com
17 West Street
Haverhill, MA 01830
9783735611

Location

139 AMESBURY LINE RD
Haverhill, MA 01830

Owner:

XENAKIS THEODORE
139 AMESBURY LINE RD HAVERHILL, MA 01830

Comments

William Pillsbury, Jun 10, 2021 at 12:32pm

Recommend approval of both special permits as presented

JAMES J. FIORENTINI
MAYOR

11.2.1

CITY OF HAVERHILL
MASSACHUSETTS

CITY HALL, ROOM 100
FOUR SUMMER STREET
HAVERHILL, MA 01830
PHONE 978-374-2300
FAX 978-373-7544
MAYOR@CITYOFHAVERHILL.COM
WWW.CI.HAVERHILL.MA.US

August 20, 2021

City Council President Melinda E. Barrett & Members of the City Council

RE: Mayor's Task Force on Public Health

Dear Madame President and Members of the City Council:

Please be advised that I hereby appoint the following to serve on the Mayor's Task Force on Public Health:

- Kevin McCarthy of Groundwork Lawrence
- Tony Slabacheski, Holy Family Hospital, Haverhill Campus, Administrator in Charge.

The Haverhill Task Force on Public Health's first mission will be to work to have the COVID-19 vaccine distributed to as many people as possible in the City of Haverhill. These are non-confirming appointments which will take effect immediately and expires on December 31, 2021.

Very truly yours,

James J. Fiorentini (LYF)

James J. Fiorentini
Mayor

JJF/lyf

12,5,5,1

City of Haverhill

Taxi Driver License – Ch.230 sec.20

pd. 50.00

Honorable President and Members of the Haverhill City Council:

The undersigned respectfully asks that he/she may receive a license to drive a taxi in the City of Haverhill

Name: Michael Brown

Address: 4 Humblet St Manchester, NH 03102

Applicant phone number: 603 931-7235

Any driver of vehicle(s) must provide name, address, DOB, SS# and Driver's license # - fill out on back.

Office use only

New/Renew (circle one)

Fee: $50 – annual fee   January 1 2019 to December 31st 2019

In Municipal Council, ______________________ 20__

Attest ______________________ City Clerk

Approve ____

Denied ____

______________________ Police Chief

Please complete back side of this application

131

DOCUMENT

CITY OF HAVERHILL

In Municipal Council

ORDERED:

To the Honorable Members of the City Council:

By virtue of the authority vested in me, as Mayor, by the City Charter and Ordinances of the City of Haverhill, and the General Laws of the Commonwealth, I have this day appointed the following persons, as attached, to serve as Precinct Officers in the several wards of the City for the year 2021:

John R.	Buzzell
Linda	Hamel
Griselda	Garcia
Barbara	Dube
Guy	Berube
Alice	Tobiassen
Judith	Biewener
Tim	Biewener
Elise	Ashley
June	Brown
Lisa	Davis
Joyce	Thibodeau
Louis	Yarid
Ed	Brewster
Jessica	Brewster
Bryan	Waters
Eric	Guilfoyle
David	Decker
Kira	Yarid
Penelope	Guerrero
Charles	Mueller
Aileen	Swider
Joe	Hakim
Gail	Desmarais
Rosalind	McKeon
Marianne	Mueller
Jennifer	Doucette
Christena	Flynn
Maxine	Rock
Oleg	Rock
Gladys	Welles
Jane	Burgess
Lorraine	Lostimolo

Jane	Jeffers
Eric	Karlstad
Anna	Tschetter
Joann	Corthell
Sue	Brewster
Roxanne	Patroni
Kimberly	Hrubes
Linda	McCarthy
Carolyn	Hannagan
Pat	Ross
Donna	Malone
Anne	Dunn
Ismael	Matias
Mary	Harris
Leslie	Brown
Biagio	Bovenga
Herb	Bergh
Kathy	Bresnahan
Nancy	Perry
Virginia	Taylor
Maria	Lagual
David	Cue
Madelaine	Thompson-Judkins
Justine	Carrigan
Ajmain	Zahid
Ambriel	Mayhew
Dan	Beauregard
Joseph	Giampa
Margaret M.	Preston
Rene	Jungers
Lawrence	Hicks
Sheryl	Ross
Catherine	Hicks
Kathleen	Connor
Diana	Vencis
Janice	Keyser
Carolyn	Layzer
Robert	Pombar
Anda	Adams
Sue	Hicks
Doug	Edison
Janet R	Senk
Steve	Arthur
Felipe	Hernandez
Cynthia	Floyd
Diane	Gurry
Rita	Gallo
Gary	Bradley

Carol	Read
Joe	Bolis
Roger	Begin
John	Woolf
Grace	Tumushabe
Richard	Klinger
Christine	Kwitchoff
Paula	Wentworth
Alice	Zujowski
Jane	Leach
Regino	DeAza
Dianne	Tarpy
Margaret	Pfifferling
Pam	Pfifferling
John	Brayton
Judith	Jewett
Pamela	Ross
Ernest	Anderson
Carol	DeOliveira
Frances	Poirier
Christina	Fabiano
Susan	Coppola
Carol	Carifio
Joe	LoGiudice
Patricia	Hobitz
Maurice "Mo"	McGuire
Eric	Wortman
Patrick	Murphy
Irl	Clevesy
Gina	Marks
Lillian	Boutin
Shawna	Kelley
Lynda	Brown
Kevin	Bergin
Robert	Simard
Janice	Taylor
Katherine	Mulcahy
Robert	Sahakian
Deryl	Santosuosso
Phil	Brown
Heidi	Blanchet
Manuel	Martines
Kevin	Parah
Jessica	Collins
Paula	Brooks
Robyanne	Cormier
Cheryl	Lupi
Frances	De Leon

Maryann	Mueller
Sandra	Finnigan
Bethel	Keller
Ed	Buckley
Kimberly	Cooper
John	Hassan
Leslie	Hassan
Denette	Abers
Tina	Morse
Walter	Gotham
Jessica	Shea
Jane	McNeal
Kathy	Welch
Susan	Gregory
Alvin	Hitchcock
Ann	Somma
Kara	Ferguson
Katelyn	Weber
Josh	Reynolds
David	McKenzie
Kathy	Renzi
Jessica	Shea

Mayor James J Fiorentini

(14.1)

CITY COUNCIL

MELINDA E. BARRETT
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COLIN F. LEPAGE
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CITY OF HAVERHILL
HAVERHILL, MASSACHUSETTS 01830-5843

August 18, 2021

To: President and Members of the City Council:

Councillor Daly O'Brien would like to discuss closing Washington Street and Wingate Street on Friday and Saturday evenings making them pedestrian only.

Mary Ellen Daly O'Brien /lab
City Councillor Mary Ellen Daly O'Brien

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14.2

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August 18, 2021

To: President and Members of the City Council:

Councillor Daly O'Brien would like to discuss a constituent's request to put an end to commercial truck traffic on Mill Street and the issue of truck traffic through residential neighborhoods throughout the city.

Mary Ellen Daly O'Brien /lab

City Councillor Mary Ellen Daly O'Brien

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City Council

Melinda E. Barrett
President
Colin F. LePage
Vice President
Joseph J. Bevilacqua
John A. Michitson
Thomas J. Sullivan
Timothy J. Jordan
Michael S. McGonagle
Mary Ellen Daly O'Brien
William J. Macek

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City Of Haverhill
Haverhill, Massachusetts 01830-5843

August 19, 2021

TO: President and Members of the City Council:

Councillor Bevilacqua wishes to discuss the opportunity for additional senior citizen housing.

Joseph Bevilacqua /lab
City Councillor Joseph Bevilacqua

(14,4)

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August 19, 2021

TO: President and Members of the City Council:

Councillor Bevilacqua wishes to recognize the upcoming 20th Anniversary Commemoration of the September 11, 2001 terrorist attacks that killed nearly 3,000 innocent people and injured thousands at The World Trade Center, The Pentagon, and a field in Somerset County, Pennsylvania.

Joseph Bevilacqua /lab

City Councillor Joseph Bevilacqua

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August 19, 2021

TO: President and Members of the City Council:

Councillor Daly O'Brien and Councillor Bevilacqua requesting to discuss the continuing neighborhood concerns with NETTS tractor trailer traffic on Monument Street.

Mary Ellen Daly O'Brien /lav
City Councillor Mary Ellen Daly O'Brien

Joseph Bevilacqua /lav
City Councillor Joseph Bevilacqua

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DOCUMENTS REFERRED TO COMMITTEE STUDY

38-W	Communication from Councillor Barrett requesting to give an update on response from MBTA/Keolis & US EPA about idling trains in Bradford	Citizens Outreach	4/5/16 1/31/17
10-B	Communication from President Michitson asking to request from Mayor status of facility improvements to public buildings and parks to comply with American w/ Disabilities Act (ADA)	Citizens Outreach	1/3/17 1/31/17, 8/15/17
10-U	Communication from President Michitson requesting discussion on next steps to provide comprehensive long range plan for Haverhill	Citizens Outreach	1/31/17 8/15/17, 4/23/18
38-D	Communication from Councillors Sullivan and Barrett requesting an update on City's emergency management plan and status of working generators in all public building in City	Public Safety	3/20/18 1/23/19
79-F	Communication from Councillor Sullivan requesting to introduce Kathleen Fitts, Gale Park Assoc. to request the city replace the Gale Park Fountain in fiscal year 20	NRPP	6/25/19
79-T	Communication from Councillors Sullivan and Barrett re: discussion with VINFEN & Haverhill Police Dept. regarding incident in neighborhood of 20 Westland Ter. group home on 7/5 and steps being taken to better supervise residents and reduce police calls to residence	Public Safety	7/23/19
89-K	Communication from Councillor Macek requesting open discussion relative to the process for Establishing a Charter Commission to review the current City of Haverhill Charter	Citizens Outreach	8/6/19
89-U	Communication from Councillor LePage re: applying for Community Compact Best Practices Program grant for benefit of city and its residents	Citizens Outreach	9/17/19
89-V	Communication from Councillor McGonagle requesting a discussion about school bus safety	Public Safety	9/17/19
11	Communication from Councilor Jordan requesting to introduce Steve Costa of Citizens for Haverhill Fire to discuss Mayor's CIP and occupational cancer	Public Safety	1/7/20
34-P	Communication from Councillor Sullivan requesting a discussion regarding the disposal of cremated remains on public property	NRPP	3/17/20
58-M	Communication from Councillors LePage and Daly O'Brien re: the possible use of Hale Hospital Trust Funds for ongoing City health care programs and issues	A & F	4/21/20
69-O	Communication from President Barrett and Councillor Sullivan requesting discussion on illegal fireworks in the City	Public Safety	7/28/20
86-D	Communication from Councillor Michitson requesting to address economic development ideas resulting from the pandemic	Planning & Dev.	8/11/20
86-F	Communication from Council President Barrett and Councillor LePage requesting discussion pertaining to utilization of UV-C disinfection fixtures in public buildings	A & F	8/25/20
89-C	Mayor Fiorentini submits final recommendations of Matrix Company	NRPP	9/15/20

DOCUMENTS REFERRED TO COMMITTEE STUDY

91	Petition from Wady & Jewnifer Grullon requesting to purchase city property that abuts their property at 14 Silver Birch Ln; Assessor's Map 574, Block 1 Lot 7	NRPP	9/15/20
91-B	Petition from the Biggart Family requesting to purchase 2 parcels of land that abuts their property at 30 Belvidere Rd., Assessor's Map 409, Block 114, Lot 9; and Map 409, Block 1A, Lot 1 that includes conservation land, but only the portion zone RMD (Residential Medium Density)	"	9/22/20
86-S	Communication from Councillors LePage, Sullivan and Macek to discuss process for approval of development projects within the Waterfront District Ch. 255, Article XVI	A & F	10/6/20
55-I	Communication from Council President Barrett and Councillor McGonagle requesting to introduce Don Jarvis, Keith Gopsill and Mike Ingham to discuss becoming a Purple Heart Community	NRPP	12/15/20
91-C	Petition of Michael DeLuca requesting to purchase surplus city land on River St., Map 538, Block 419B, Lots 20, 21, 22, 23	NRPP	12/15/20
4-I	Communication from Councillor Michitson requesting to address the rising inequities between high and low paid occupations in the United States	Citizens Outreach	1/12/21
4-Q	Communication from Councillor Macek requesting discussion on parking space requirements per zoning regulations throughout City	A & F	2/2/21
27-E	Communication from Councillor Sullivan requesting to introduce Debbie Lyons, to explain having legal permitting system as it relates to establishing permitting/licensing process to allow for "Bow Hunter Tree Stands" to be placed on trees on City properties when hunting is allowed in season	NRPP	3/2/21
27-J	Communication from Councillor Michitson requesting to re-start discussion on way ahead for residential zoning in Haverhill	Planning & Dev.	3/9/21
50	Councillor Jordan requests on behalf of Tom Riley, 195 Kingsbury Ave., to have city surplus land that abuts his property, Map 768, Block 50, Lot 85A on Lincolnshire Ave.	NRPP	4/6/21
27-X	Councillor Daly O'Brien requests discussion re: cars parking on Concord St. sidewalks and possibility of city providing off-street parking	NRPP	4/6/21
50-U	President Barrett and Vice President LePage request discussion about composting options	Citizens Outreach	5/18/21
50-W	Councillor McGonagle requests to discuss an option to reward first responders and frontline workers to receive bonus for working through pandemic	Public Safety	5/18/21

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LONG TERM MATTERS STUDY LIST

38-F Communication from Councillors Barrett and LePage requesting to discuss doublé poles in the City
A & F 3/15/16, 9/6/16, 11/3/16, 1/17/17, 5/11/17, 10/24/17, 3/6/19

26E City of Haverhill – Mayor's Recommendations, Capital Improvement Program – 2016-2020
A & F 5/31/16, 11/3/16, 5/11/2017, 7/25/17, 2/15/18, 3/6/19, 4/17/19

93-L Communication from President Michitson requesting to introduce Dave Labrode to discuss street tree plantings
NRPP 8/7/18, 2/28/19, 2/27/20

38-J Communication from Councillor Macek requesting a discussion about reserve parking spaces at City Hall designated for Registry of Motor Vehicles
NRPP 3/19/19, 2/27/20

13-Y Communication from Councillor LePage to discuss accounting of revenue funds received from Licensed Marijuana establishments & their allocation to mitigate costs and impacts to city
A & F 3/12/19, 8/5/19

89-D Communication from Councillors LePage, Michitson, Jordan requesting discussion on reducing exposure of persons under 21 yrs. of age to outdoor advertising (billboards) of marijuana productsand zoning regulations pertaining to smoke and/or vapor stores in Haverhill
A & F 7/23,19, 8/16/19