Ahead of the Storm
Education and Outreach
Site Design Process

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Funded by the Lake Champlain Basin Program - L-2019-032 EO AOTS Project

Review Site Assessment –

- **Finish site assessment**
  - **Flow path lines**
  - **Erosion areas**
  - **Existing stormwater infrastructure**
  - **Notes on impervious and landuse**
  - **Think about constraints**
- **Identified problem areas**
- **Identified potential treatment areas**

Students share results – show maps

Look at delineation between Subsheds

Alternatives Analysis

- **Treatment Goals**
- **Site Constraints**
- **Permit Constraints**
- **Design Lifespan**
- **Constructability**
- **Construction Cost**
- **Maintenance Cost**

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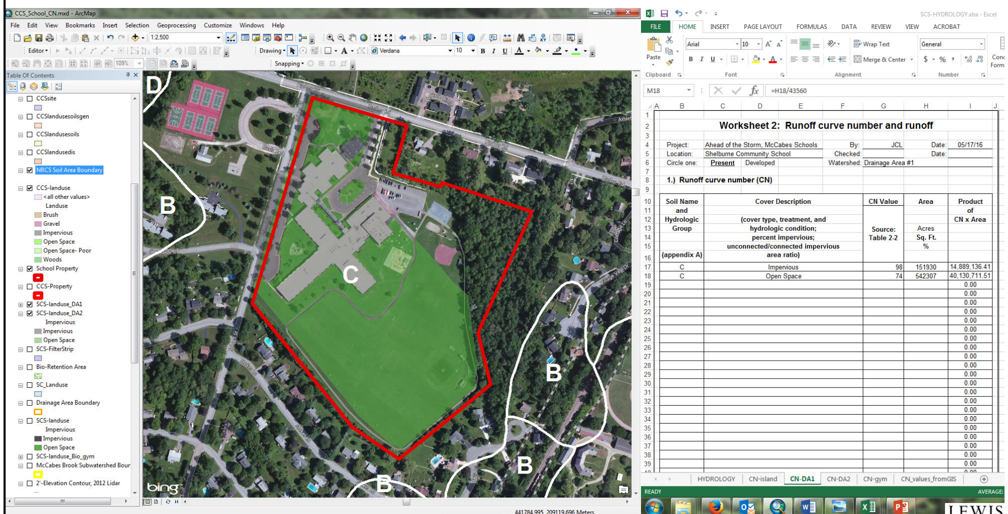
These are all things we need to consider when choosing a design.

Is there anything missing from this list?

Aesthetics? – what does it look like

Habitat? – will birds be attracted

Alternatives Analysis - Calculate Runoff Volume



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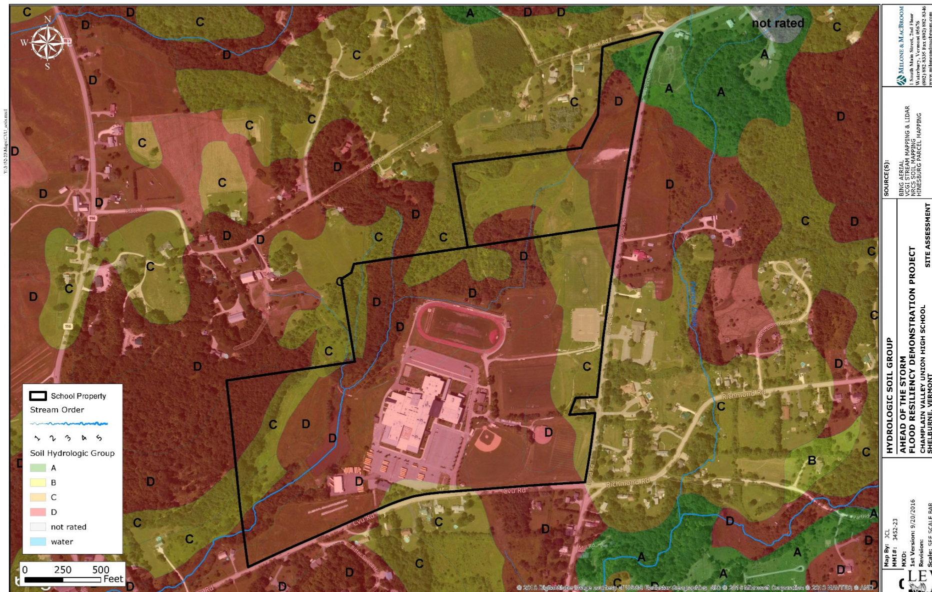
We need to know how much water is going to get to our potential treatment areas so that we can judge what types will work and if there is enough space for them

First we define the watershed area.

Hydrology - Soils



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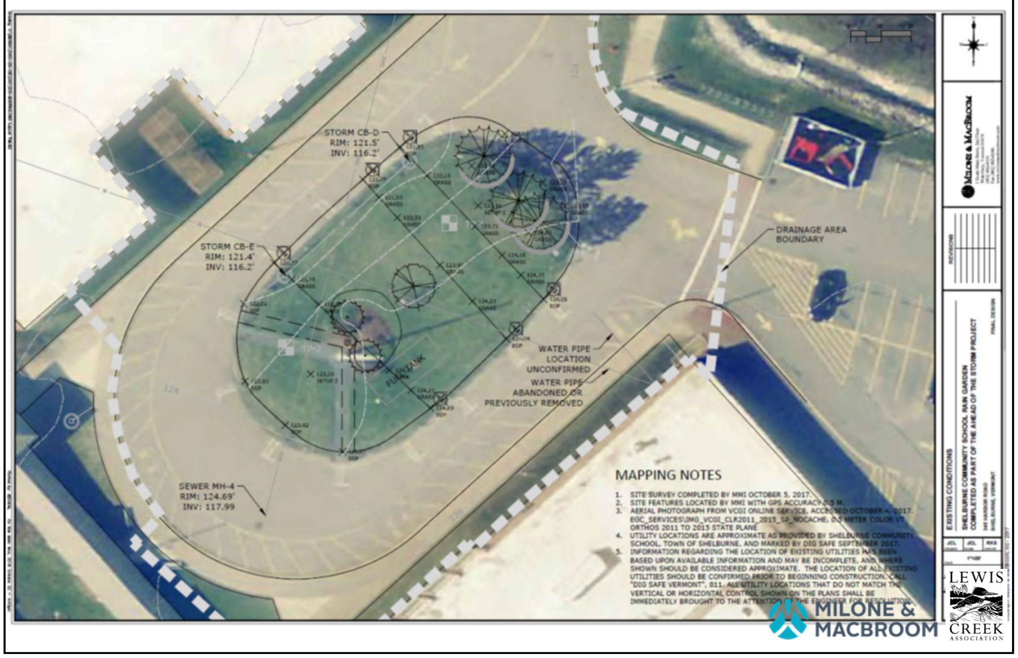
We need to know what type of soils there are.

Soils have different natural infiltration rates that affect how much runoff there is

These are combined with the landuse – grass, woods, impervious

Alternatives Analysis- Calculate Runoff Volume



As an example, during the site assessment you identified an area that could be a potential treatment area

You determine how much area drains to the site, maybe you did this during the site assessment.

Alternatives Analysis- Calculate Runoff Volume

Drainage Area Information					
Pre Development Land Use (acres)					
Landuse	A	B	C	D	Total
Grass	0.000	0.000	0.300	0.000	0.300
Meadow	0.000	0.000	0.000	0.000	0.000
Woods	0.000	0.000	0.000	0.000	0.000
Existing Impervious	0.000	0.000	0.500	0.000	0.500
npervious previously authorized under 2002 VSMM (not included in calculations)					0.000
Total Pre Site Area					0.800

WQvolume = P * Rv * A / 12

Where

P = precipitation = 1 inch across Vermont = **1**
Rv = runoff coefficient = (0.05 + 0.009 * I) = **(0.05+0.009*62.5) = 0.6125**
I = percent impervious = **62.5%**
A = site area (acres) = **0.8 acres**

WQvolume = (1 * 0.6125 * 0.8) / 12 = 0.0408 acre-feet

= 1,779 cubic feet

Like a 25-foot square room with 3 feet of water

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Water Quality volume is the amount of water that would runoff the project area during the 1 inch rainfall amount.

This is a standard treatment volume in the State stormwater manual and is calculated based on drainage area, impervious area, and constants

It calculates how big our treatment area needs to be to treat the water draining to the site.

We need this for design

Here is an example from the Shelburne Community School raingarden in front of the school

Alternatives Analysis- Calculate Runoff Volume

Watershed Location	Total Watershed Area (Acres)	Site Area (Acres)	Impervious Area (Acres)	Impervious Area (%)	Water Quality Volume (Cubic Feet)*
To Center Island	3.8	0.7	0.3	36.0	**855**
To Outfall #2	3.8	3.8	2.0	53.0	**6,542**
To Area near Gym	15.9	0.1	0.1	36.0	**171**
To Outfall #1	15.9	15.9	3.5	22.0	**12,882**

12,882 cubic feet is like:
2 feet of water over the basketball court to east of school

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You may have multiple potential treatment areas with different treatment volumes.

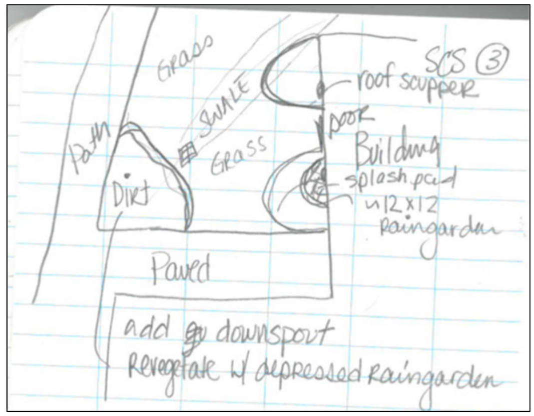
Many stormwater treatment areas area built to handle more water than the WQv, which is a minimum.

There are also standards for the amount of water you need to infiltrate based on soil type, to recharge groundwater

and larger storms where you need to hold the water for a certain amount of time to not increase the peak runoff volume or flow rate

Alternatives Analysis- Consider OCP Options

- Soils
- Infiltration Capacity
- Appropriate location
- Available space
- Where is water collected
- How much water collected
- Constraints – utilities?
- Maintenance needs
- Type of pollutants present
- Problem areas – Erosion?



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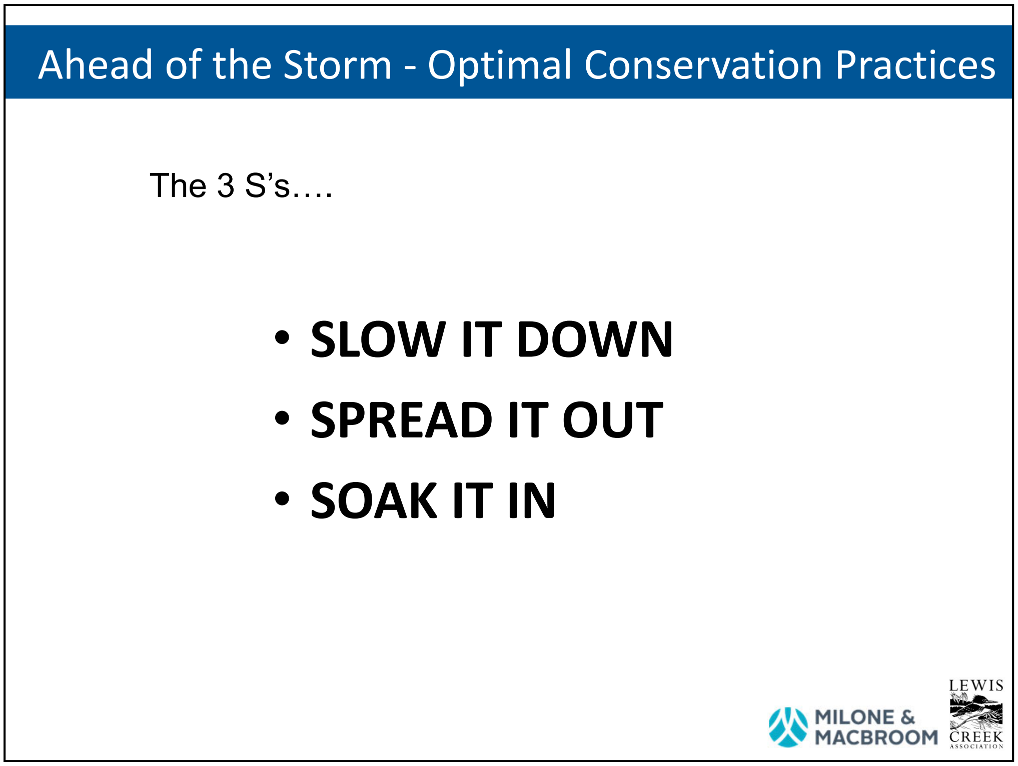

HANDOUT – Design Principles for Optimal Conservation Practices – use the one from AOTS Information Packet

Ahead of the Storm - Selecting Practices

Stormwater Practice Definitions

- **Best Management Practices (BMP)**
- **Green Stormwater Infrastructure (GSI)**
- **Low Impact Design (LID)**
- **Optimal Conservation Practices (OCP)**

BMPs reduce the quantity and improve the quality of stormwater – they can be an action or a structural improvement (something you build)

GSI are BMPs that promote natural ecological function on site specifically to restore and maintain natural hydrologic processes, many include plants which evapotranspirate

LID are land planning and site design practices that limit the amount of impervious surface and minimizes environmental degredation when designing a development

OCP takes these a step farther to where possible treat stormwater from larger weather events and protecting ecosystem functions – the approach may include designing something above the minimum requirements for permit compliance

Some practices can fall within all of these categories – like a raingarden

Rainbarrel / Cistern

Vermont LID Manual, VTDEC, 2010

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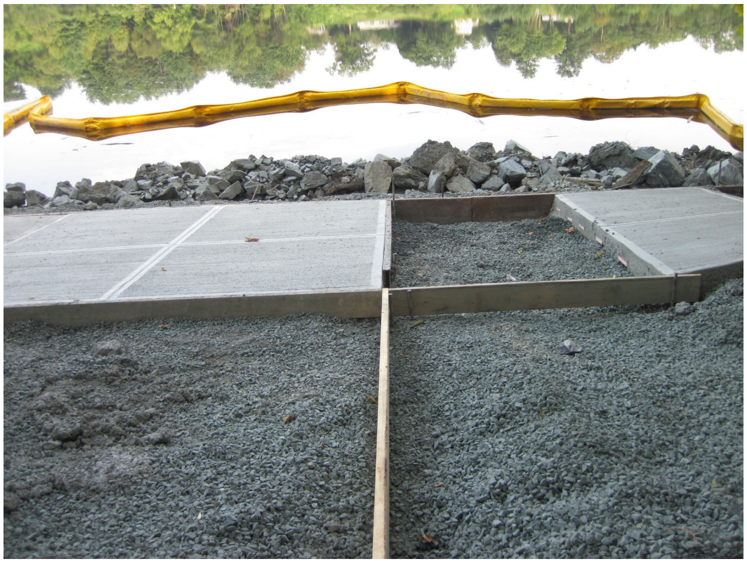
Rainwater harvesting = storage and reuse

Can use water for irrigation, gardening

I use my home rainbarrel for watering my indoor plants too.

Pervious Pavement or Concrete



Dartmouth College, Connecticut River Edge, Hanover, NH, Summer 2013

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Infiltration - This could also be pavers (like bricks)

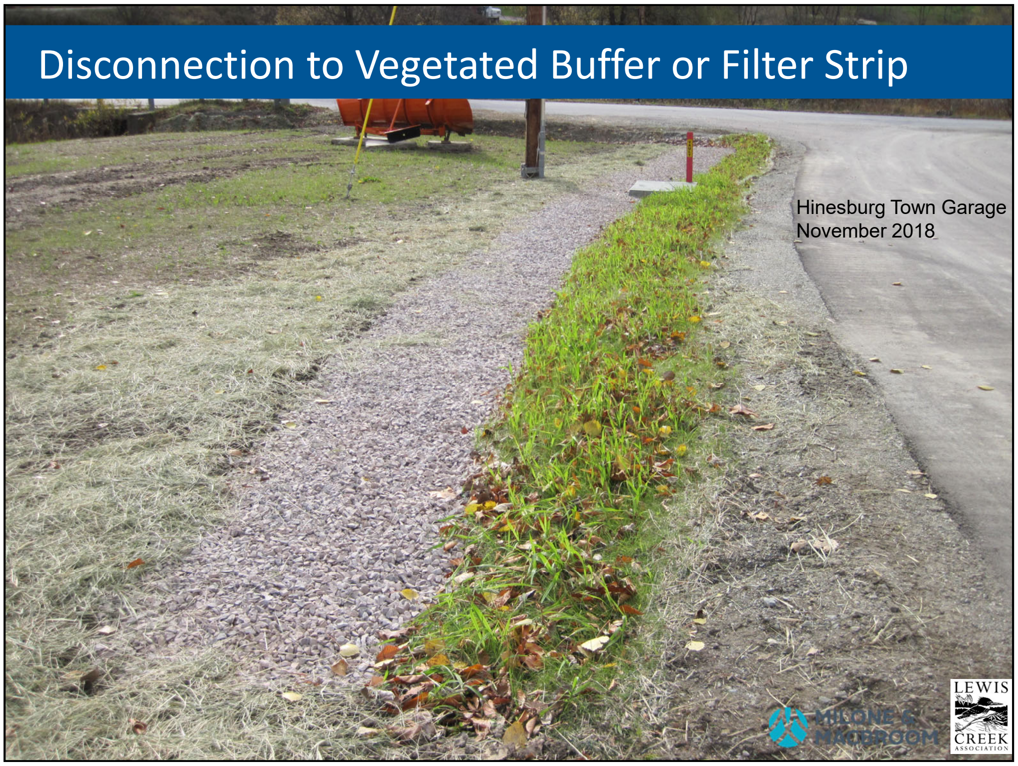
It is a hard surface that has pores so that water can run though it and into the ground below.

Ice, salt, and sand can be issues with this type of treatment because it can get clogged and is flat, so rain has to get into it quickly or runs off

Trees act as natural reservoirs – intercept and store rainfall

Reduces stormwater runoff

Need to be planted in uncompacted soils



Water flows off of an impervious surface and spreads out over a vegetated area
Sometimes a gravel strip is included to slow down water and do some filtering
Important that the water is spread out

Raingarden / Bio-Retention

Town Property, Silver Street, Hinesburg, Summer 2014

A Family's Home, Charlotte, Summer 2018

Shallow, vegetated basins that collect and absorb runoff

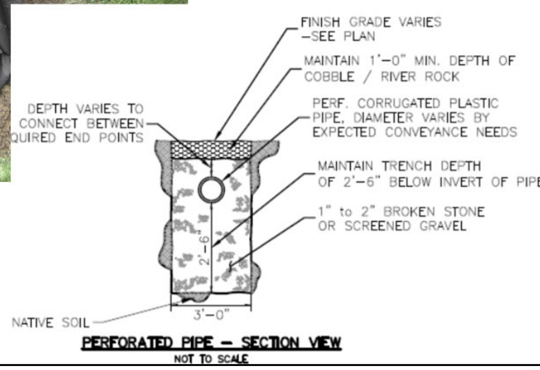
Includes evapotranspiration – water released to the air when plants breath

If possible infiltration,

but if soils are poor – can have underdrain that collects water after it filters through the soils

Infiltration Trench

Brook Lane, Shelburne, Vermont, Summer 2016



Allows water to seep through the stone and out into the ground

Stone provides filtering

If there is a pipe, it would have holes in it to allow the water to get into the ground

Infiltration Galleries

Hullcrest Road, Shelburne, Vermont, Summer 2012, photo by: Bernie Gagnon

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Green Roofs

UVM Aiken Building, photo taken June 2013

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A roof of a building covered with special soil and plants

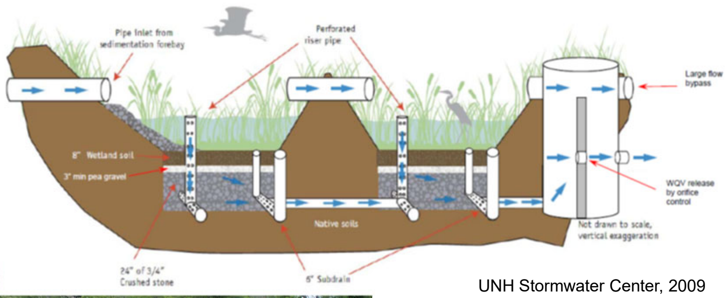
Stores and treats water on the roof, where it lands.

Absorbs, Stores, Evapotranspire

Most cost-effective where there isn't much land available – like in cities

Not all roofs are strong enough to hold the extra weight

Constructed Wetland



UNH Stormwater Center, 2009

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Shallow depression designed to mimic natural wetlands

Lots of plants

Water moves through wetland underground and is filtered

Vegetated Swales

Reconstructed grass swale, East Thompson Point Road, Charlotte, Vermont, Summer 2016

Swale with Raingarden, Woodbine Road, Shelburne, 2017

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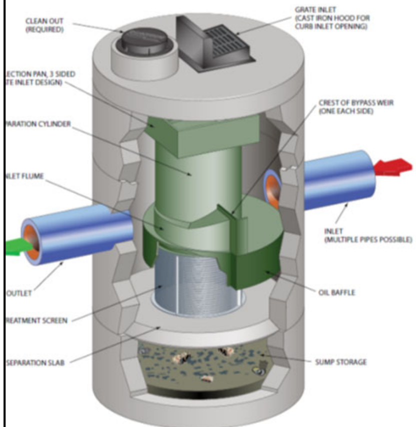
Provide treatment and retention as they move water

Slow, infiltrate, and filter better than narrow unvevegetated swales

Wide bottom, shallow slopes, vegetated

If steep, need rock to slow the water down and prevent erosion

Hydrodynamic Separator



Contech Stormwater Solutions, CDS Unit

Contech Vortechs Unit being installed in Swanton, VT Summer 2016

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Sometimes when the water is already collected in a pipe system, a more structural approach is needed

A separator swirls the dirty water around and allows the sediment to settle out into the bottom and it can be removed

A normal catch basin does not collect much of the sediment and it then travels down the pipes

Design Resources

The Vermont Rain Garden Manual "Gardening to Absorb the Storm"
http://www.uvm.edu/seagrant/sites/default/files/uploads/publication/VTRainGardenManual_Full.pdf

Vermont Low Impact Development Guide for Residential and Small Sites
https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw_LID%20Guide.pdf

Vermont Green Stormwater Infrastructure (GSI) Simplified Sizing Tool for Small Projects
http://www.vpic.info/GreenInfrastructureCalculatorsAndSizingTools.html

Vermont DEC Stormwater Program
http://dec.vermont.gov/watershed/stormwater

University of New Hampshire Stormwater Center
http://www.unh.edu/unhsc/

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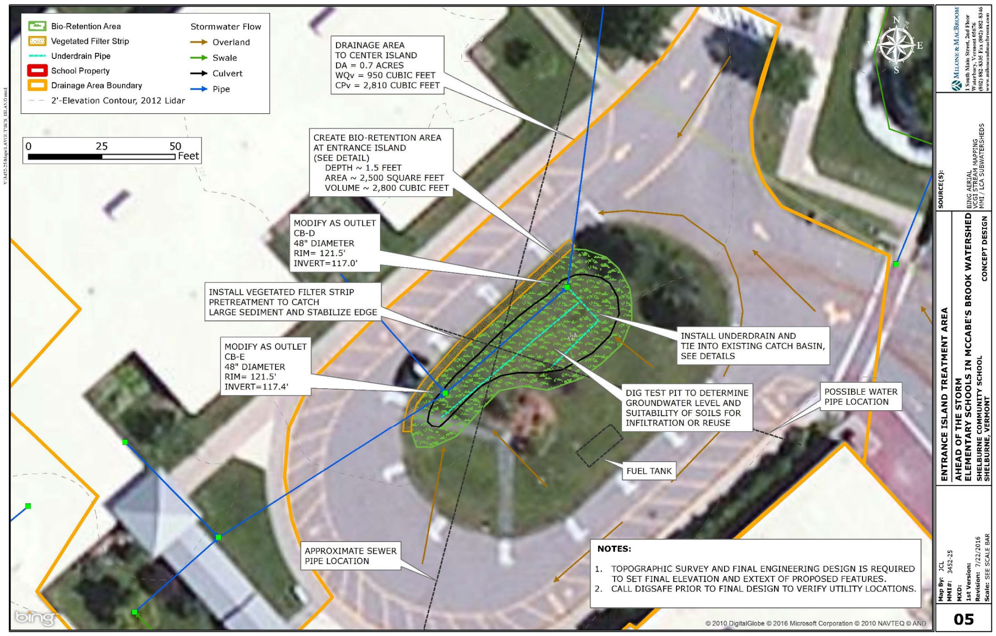
Layout Example



Here are some examples of what a concept design might look like

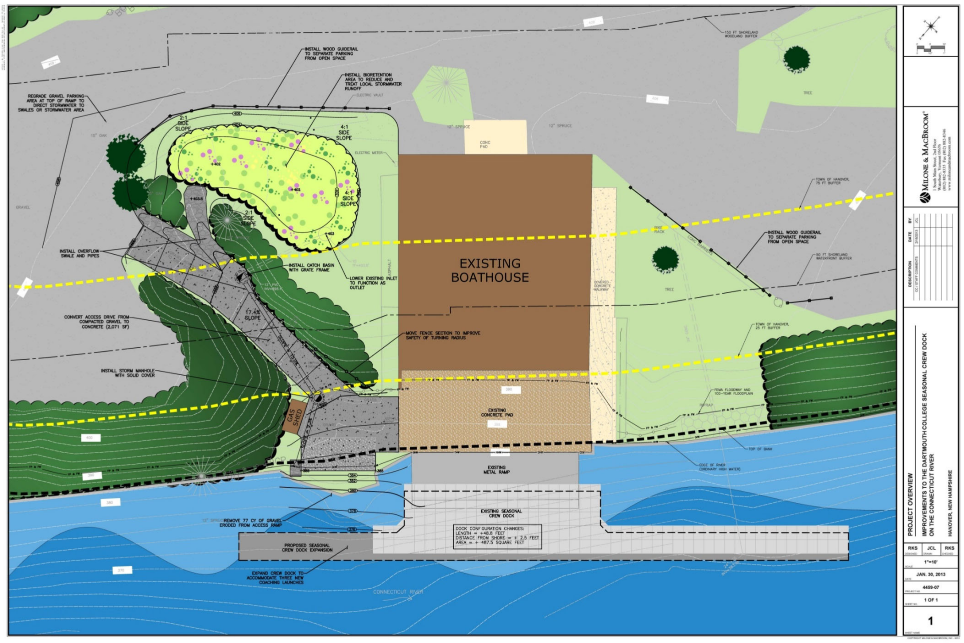
Notes on an aerial photo

Areas circled where treatment can go

Arrows for where water flows

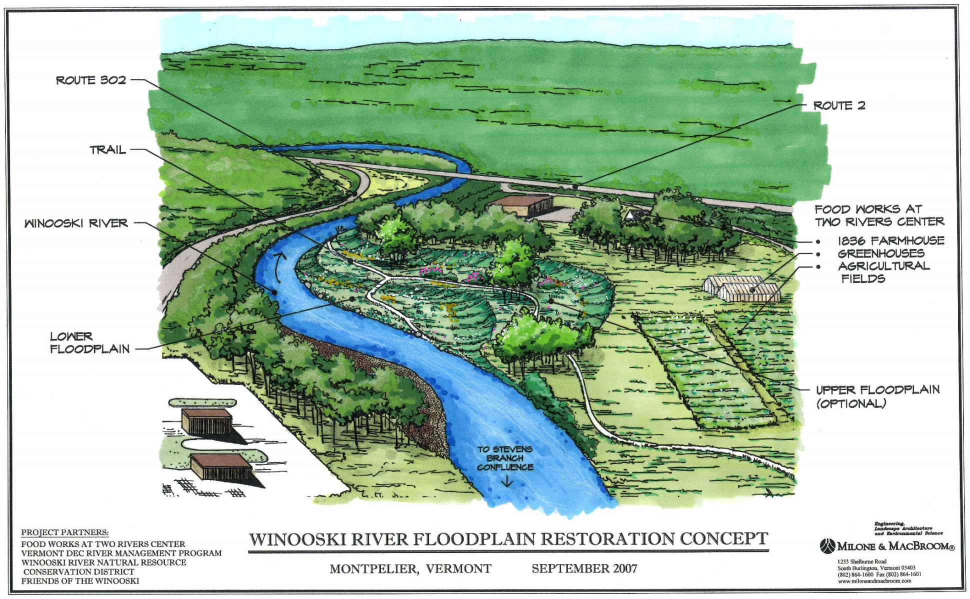
Constraints – utilities, benches, flagpoles- other things that can't be moved

Site Layout



Sometimes site features can be colored in so you can clearly see where things are going to go and what they might look like

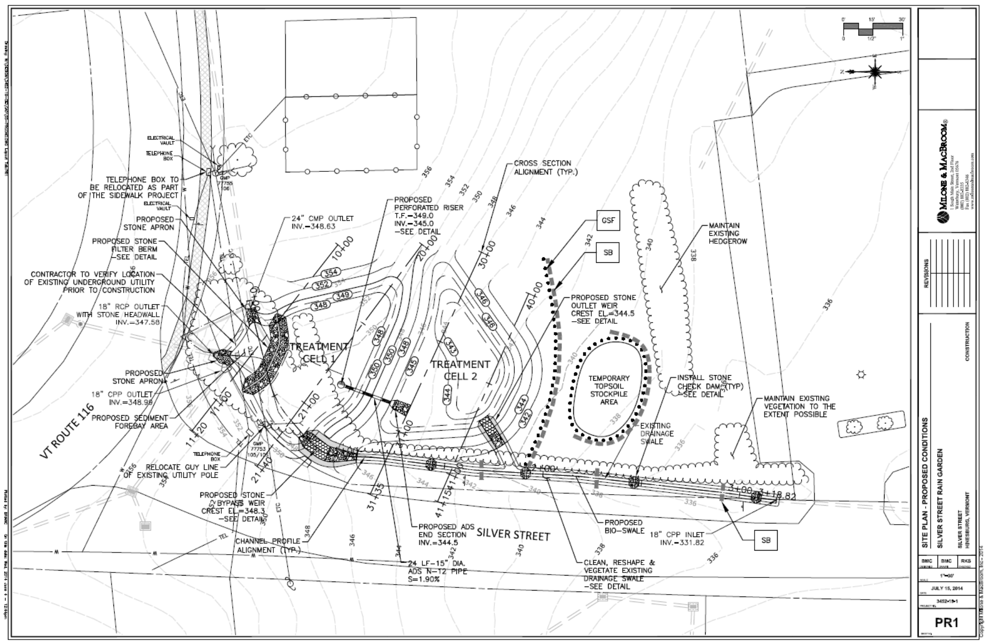
Site Layout



Similarly, this is a perspective rendering

Landscape architects often use this type of drawing to show what a design will look like

Site Layout

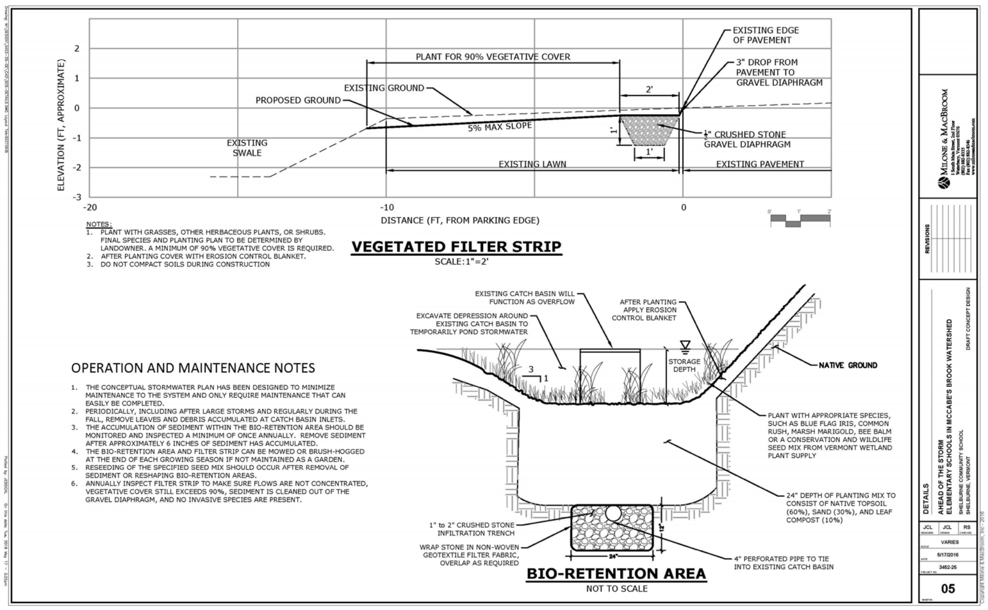


Sometimes designs have survey, (blueprints)

Less colorful, but a contractor can follow these for construction

Usually needed for more advanced designs

Design Plans - Details



Engineering details give specific information on how things need to be built

Slopes, depths, angles, size of stone, the type of erosion fabric

Maintenance notes are sometimes included here

Do this at Home!

- **The Ahead of the Storm process can be done on any type of property – and has – schools, churches, homes, public buildings, town garage, town forest…**
- **The design process is transferable**
- **Start at the beginning with a site assessment**

Many of the treatment options are easily implemented and don't need the expertise of an engineer.

Install a rain barrel, spread out water from a downspout or concentrated on a driveway.

Discuss what steps might need to be done by an engineer – have students look at the handout and identify things they could do or might need help with.

Design – Field Activity

- **Look at problem areas**
- **Identify possible locations for additional stormwater treatment**
- **Think about solution types**
- **Discuss site constraints**
- **Review Site Assessment Goals in Field**
- **Answer questions**

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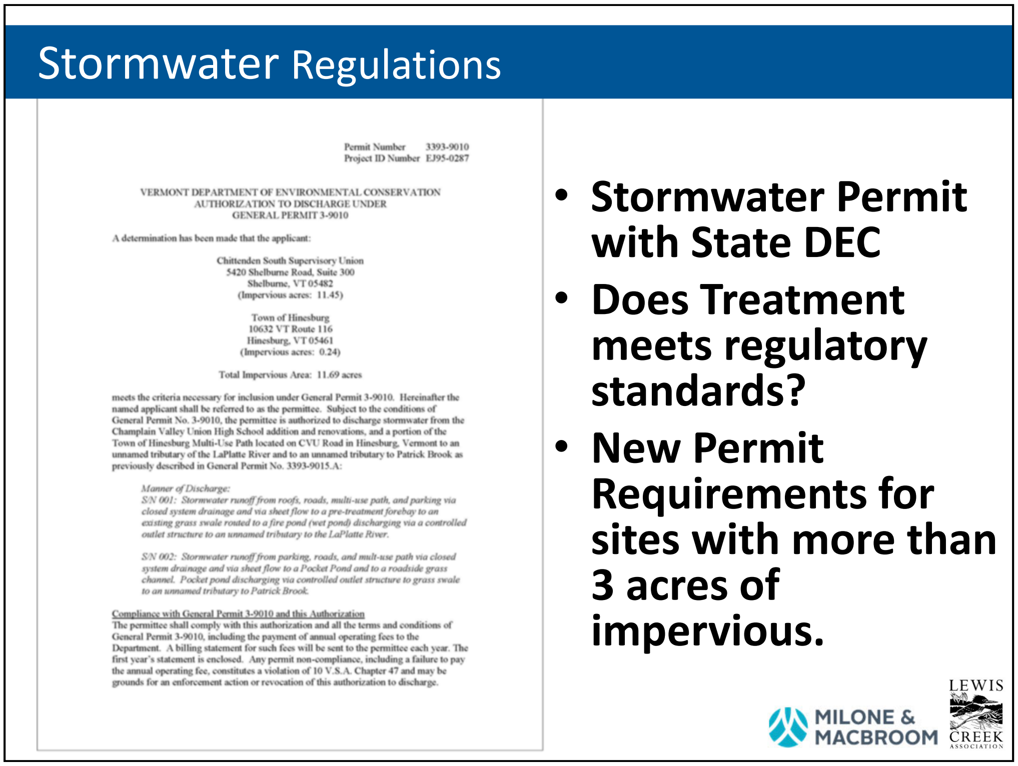
Homework –

- **Finish site assessment (Review Design Process handout)**
  - **Locate problem areas**
  - **Locate areas of existing treatment**
  - **Locate possible locations for treatment**
- **Start Design**
  - **Think about solution types**
  - **Note site constraints**
  - **Choose recommended actions and sketch on site plan**
- **Review Optimal Conservation Practices Design Principals Handout**

This is likely only for more advanced students.

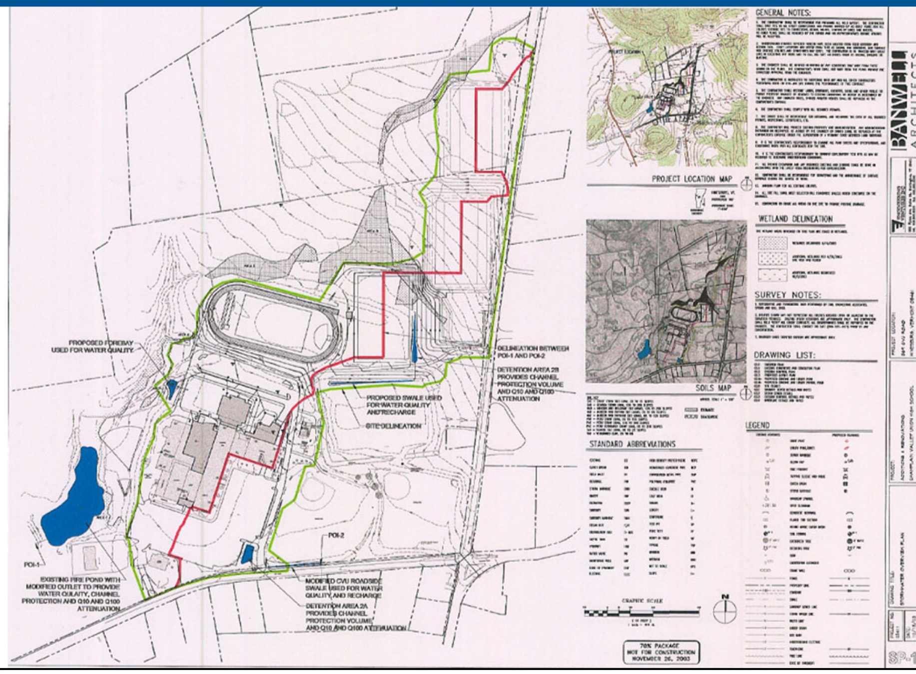
More advanced concepts

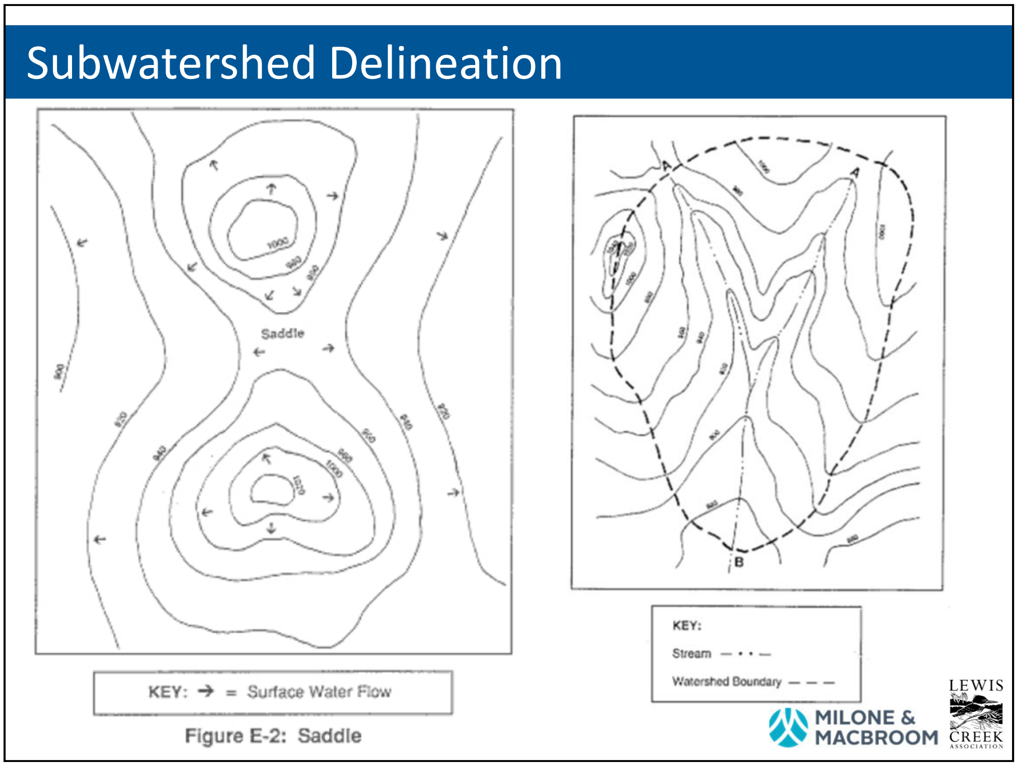
- **Maybe these are for older students or teachers only?**



Many existing properties do not fall under even these new more advanced regulations and runoff from that existing impervious surface is not treated.

Permit Drainage Area Mapping – Example - CVU





In the field exercise we delineated a watershed/ drainage area to our practice by walking around and finding the “high spots”

Those high spots were our boundaries.

This can also be completed using contours on a map

where rivers and ridges make V shapes

Draw boundaries perpendicular to the contour lines

Advanced Hydrology

- Design needs to accommodate safely larger storms than the WQv
- Treatment is typically provided for the Channel Protection Volume
  - 1-year, 24-hour storm
  - Match pre-development timing, volume, flow
- Overbank Protection Standard
  - 10-year, 24-hour storm
  - Match pre-development peak flow rate

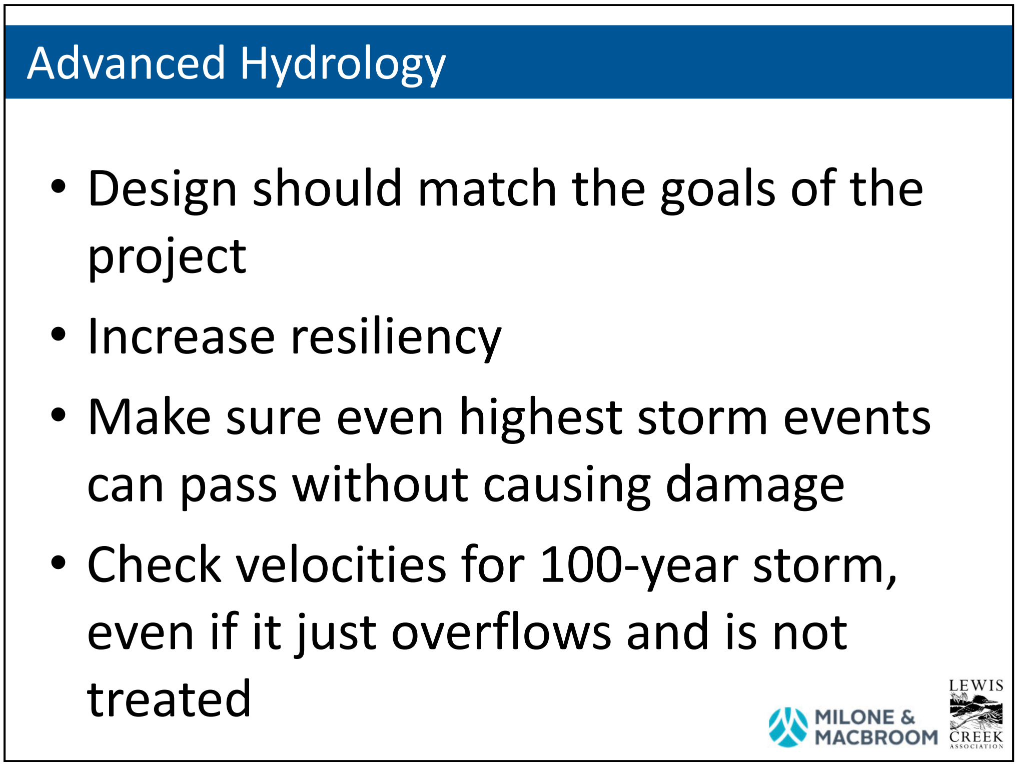
Describe general methods for calculating velocity, CPv, and flows for rain events 2, 10, 50, 100 yr

Would have to treat the 100-year storm to not increase peak flows if developing more than 10 acres.

Detailed drainage areas

Landuse/ soils analysis – done in GIS

Hydrology modeling – combining landuse, soils, flow path length, and uses modeling software



What size rain event is treatment practice designed for?

If treating for phosphorus removal – filter or infiltrate a volume greater than the WQv

If flooding and erosion downstream – detain a volume larger than the CPv – try for the 10-year

Maximize infiltration, storage, spreading water

Reduce any concentrated flows

Circle back and see if there are ways to reduce creation of impervious surface, or restore pervious.

Next Steps

- Gather Feedback
- Finalize Concept Design
- Cost Opinion
- Fundraise and Gain Support
- Final Design
- Permits
- Construction Plans
- Implement

AHEAD OF THE STORM
Stormwater Resilience Demonstration Site
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