Module 3 – Site Planning for LID

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Learning Objective 3.1

- Identify the different levels of planning and design in which LID can be achieved.

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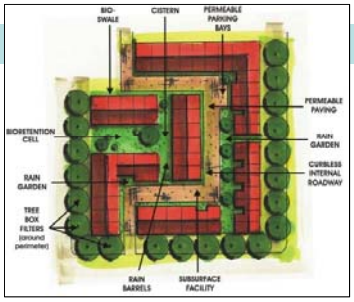
Various Levels of LID

Master Planning

- Installation Design Guide (IDG)
- Area Development Plan (ADP)
- Installation Development Plan (IDP)



Source: WERF

Site Planning and Design

- Planning Charrettes
- DD Form 1391

Source: LID Center

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LID and Master Planning

Scales of Master Planning

Vicinity Scale
1"=1000'

Installation Scale
1"=500'

Area Scale
1"=200'

Site Scale
1"=20'

Land Use	Land Use	Imperviousness
Various degrees of imperviousness due to types of land cover and activities	•Industrial •Professional/Institutional/Community •Residential •Ranges and Training •Open Space and Water	Highest ↕ Lowest

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Learning Objective 3.2

Paradigm Shift: Learn to integrate LID principles into traditional site planning process

- UFC 3-210-01A Area Planning, Site Planning, and Design
- UFC 3-210-06A Site Planning and Design
- Army Draft SOP – Integrating LID into MILCON Process

LID Design Fact:

A good LID design incorporates site planning principles as well as structural BMPs to achieve site performance objectives

Site Planning + LID BMPs = A Successful LID Design

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Site Planning for LID

Step 1 - Site inventory

Step 2 - Opportunities and Constraints

Step 3 - Preliminary calculations

Step 4 - Nonstructural LID Techniques

Step 5 - Structural LID BMPs

Step 6 - Evaluate LID Controls

Step 7 - Recalculate for final review.

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LID Site Design Goals

- Plan first
- Prevent. Then mitigate
- Manage stormwater as a resource – not a waste
- Mimic the natural water cycle
- Replicate pre-development hydrology where possible
- Integrate natural systems
- Disconnect. Decentralize. Distribute
- Maximize the multiple benefits of LID
- Use LID everywhere, and
- Make maintenance a site parameter.

"Sustain the Mission – Secure the Future"

-Army's policy for the protection and enhancement of the environment

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Step 1: Site Inventory

Goal: Integrate LID into current site planning and design strategies.

Environmental and Man-Made Features to Consider in LID Design

- Geological Conditions
- Soils
- Hydrology
- Topography
- Natural Resources
- Land Use/Land Cover
- Facilities Infrastructure

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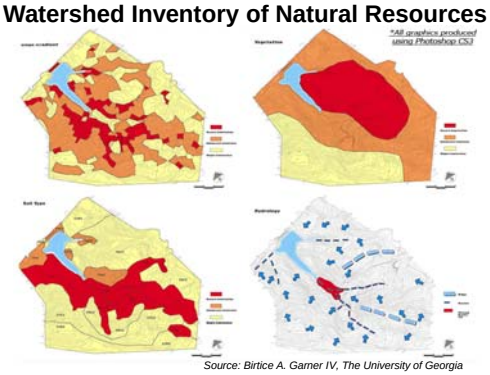
Step 1: Site Inventory

Goal: Maintain pre-development hydrology by avoiding, minimizing and/or mitigating project impacts to the site's hydrology.

Question:
How will the pre-development hydrology of the site be altered by the proposed project?

Think:
Watershed → site specific scale

Watershed Inventory of Natural Resources



Source: Birtice A. Garner IV, The University of Georgia

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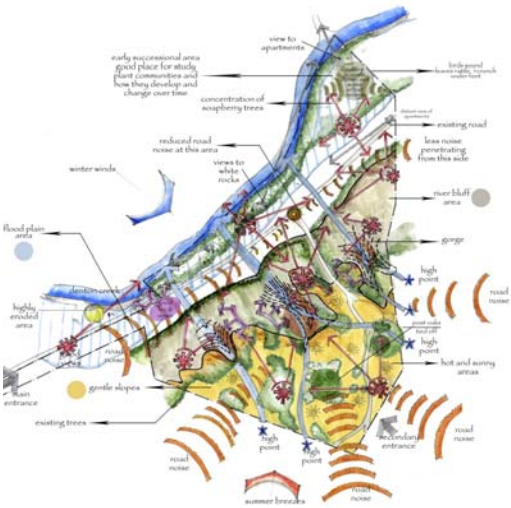
Step 1: Site Inventory

- Natural resources include: Floodplains, Streams, Riparian areas, Wetlands, Natural drainage ways, Soils and topography, Geology, Groundwater supplies, Vegetation, Protected Habitats
- Built environment include: Buildings, Roads, Sidewalks, Utilities, Fences, etc.
- Other Constraints: Property boundaries, Adjacencies, Utility easements, Zoning restrictions, Security standoff distances



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Step 1: Site Inventory

Physical Influences

Hydrology/Flooding:

- How has the pre-development hydrology of the site been altered?
- Does the site drain to nearby water bodies?
- What level of flood protection exists?
- Are there known downstream flooding problems, or known problems with run-on from neighboring properties? (is there a water quantity requirement)

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Step 1: Site Inventory

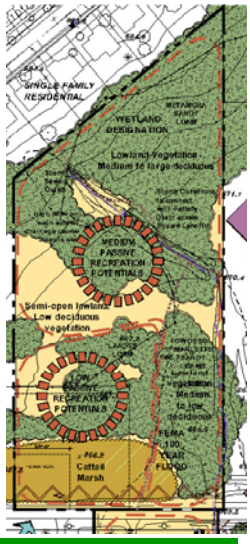
Physical Influences

Habitat:

- What was the (likely) original vegetative cover? (e.g. meadow or woods)
- Are there any endangered species or protected areas on or near the site?
- Do special fishery issues exist (e.g., trout stream)?

Water Resources:

- Are there special water quality requirements in the water shed? (e.g. Total Maximum Daily Load)
- Are there known sources of pollutants on or upstream of the site? Mining, groundwater plume, industry, brownfields, etc.
- What impact will the site's runoff have downstream?



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Step 1: Site Inventory

Planning Influences

Land Use:

- What are major land uses on & around the site?
- What types of impacts might upstream land uses have on the site?
- Are there any recreational or public features? Trails?
- Is additional development anticipated for the area that could lead to further restrictions (e.g., protection of downstream land and water uses) or opportunities (e.g., partnerships in multi-site water quality or quantity controls)?

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Step 1: Site Inventory

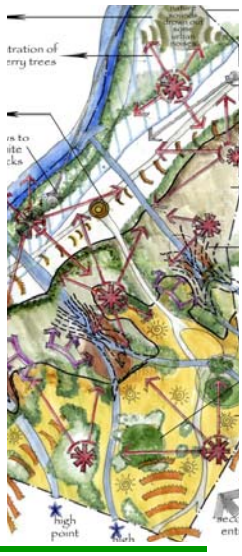
Utilities Influences

Water Supply:

- Is there a groundwater aquifer? Is it recharged 100% local rainfall?
- What is the source(s) of potable water for the site?
- Is there an opportunity for water reuse/rainwater harvesting?

Other Utilities:

- Identify major utilities running through the site: water, sewer, steam, oil, gas, communications, cable, power, storm drain, etc.



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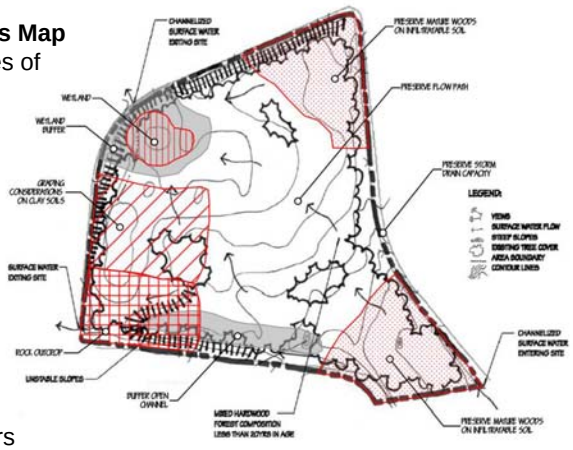
Step 2: Assess Opportunities and Constraints

Opportunities and Constraints Map addresses the physical attributes of the site.

Opportunities:
- Preserve riparian buffers
- Protect existing topography
- Preserve permeable soils

Constraints
- Steep or unstable slopes
- Contamination risks
- Impermeable soils
- Risks of flooding
- Wetlands and wetland buffers
- Streams and riparian buffer



Source: UFC 3-210-01A, 2004

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Step 2: Assess Opportunities and Constraints

Watershed-scale evaluation
Example Questions

- Does the site drain to special water bodies with special water quality needs (e.g., impaired waters, groundwater aquifer, natural river designation)?
- Does the site ultimately flow into a reservoir, groundwater aquifer, or other type of impoundment where special water quality sensitivities exist, such as use as a water supply source?
- Do other special fishery issues exist (e.g., trout stream)?
- Is the site linked to a special habitat system? (For both water quality and temperature reasons, approaches and practices that achieve a higher order of protection may become especially important.)
- Are there known downstream flooding problems, or known problems with run-on from neighboring properties?
- Is additional development anticipated for the area that could lead to further restrictions (e.g., protection of downstream land and water uses) or opportunities (e.g., partnerships in multi-site water quality or quantity controls)?

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Step 2: Assess Opportunities and Constraints

Site specific scale evaluation
Example Questions

- What are the important hydrological functions of the site, including both surface and groundwater movement?
- What important natural resources exist on site (high quality wetlands, woodlands, special habitat, etc.)?
- What are the existing soil types? Are there opportunities for infiltration?
- What is the depth to the water table?
- What is the depth to bedrock?
- How does size and shape of the site affect stormwater management?
- Are there areas where development should generally be avoided? (Determine where buildings, roads, and other disturbance should be avoided, in terms of avoiding existing natural resource systems and rights of way).
- Are there areas where runoff infiltration should be avoided because of historical land uses and/or contamination?

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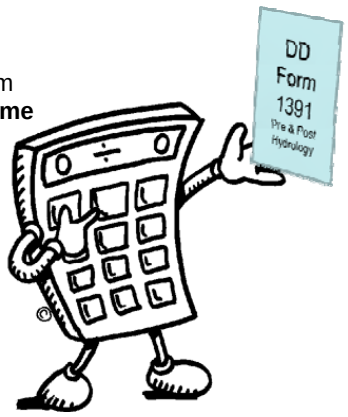
Step 3: Preliminary Calculations

Preliminary calculations using pre- and post-development site parameters:

- Development Project Requirements during
  - Planning Charrette
  - DD 1391 Development
- Site configuration and site boundary estimate
- Calculate the difference in stormwater runoff from pre- and post-development = **EISA Runoff Volume required to be managed on site**
- Revise preliminary calculations throughout the project as LID features incorporated

(refer to Module 5 Simulation Support of ARMY LID WORKSHOP)



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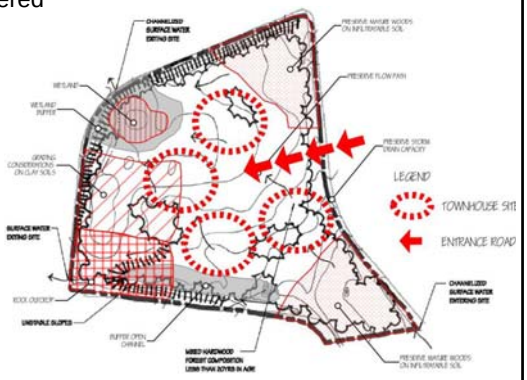
Step 4: Non-Structural LID Techniques

Objective: To develop a plan with the least impact on the hydrologic function.

Using Opportunities and Constraints Map:

- Determine, locate and avoid conservation areas
  Examples: Habitats for endangered species, wetlands, aquifer recharge, flood plans, water bodies, riparian zones, steep slopes, etc.
- Development footprint should be sited to allow LID opportunities
- Configure site to imitate natural hydrology
- Conform to local watershed, conservation, and open space plans



Concept Design with Non-Structural LID BMPs
Source: UFC 3-210-01A, 2004

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Step 4: Non-Structural LID Techniques

Non-Structural LID BMPs:

- Minimize Total Disturbed Area
- Preserve Natural Flow Pathways and Patterns
- Protect Riparian Buffer Area
- Protect Sensitive Areas
- Cluster Development
- Minimize Soil Compaction
- Reduce Impervious Surfaces
- Site Fingerprinting

Detailed Site Design Using Non-Structural LID BMPs
Source: UFC 3-210-01A, 2004

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Step 5: Structural LID BMPs

Determine what structural BMPs that best achieve a specific site's stormwater needs. Not all structural BMPs are appropriate for every installation at every site. Maximize treatment trains.

Example Questions:

- Meets runoff quantity?
- Meets quality needs?
- Manage close to source with collection/conveyance minimized?
- Consistent with site factors (e.g. soils, slope, pollutant removal needs)?
- Ease of maintenance?

Bioretention
Source: UFC 3-210-10, November 2010

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Steps 4 and 5: LID BMPs

Typical Street for Military Housing
Source: UFC 3-210-10, 2004

Street with Structural LID BMPs for Military Housing
Source: UFC 3-210-10, 2004

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Step 5: Structural LID BMPs

LID Practice / Device	Peak Flow Control	Volume Reduction	Water Quality Improvement	Water Conservation
Bio-retention Cell	•	•	•	
Cistern	•	•		•
Curbless Parking Lot Islands	•	•	•	
Downspout Disconnection	•	•	•	
Grassed Swale	•	•	•	
Green Roof	•		•	
Infiltration Trench	•	•	•	
Narrow Road Design	•	•	•	
Permeable Pavers/Pavement	•	•	•	
Rain Barrel	•	•		•
Rain Garden	•	•	•	
Sand Filter	•		•	
Tree Box Filter	•		•	
Tree Planting	•	•		

Source: WBDG Design Guide: Low Impact Technologies
http://www.wbdg.org/design/lidtech.php

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Step 5: Structural LID BMPs

Source: Low-Impact Development Design Strategies, prepared by Prince George's County, Maryland

Maintenance	Max. depth	Proximity to building foundations	Water Table/Bedrock	Slopes	Soils	Space required	
Low requirement, property owner can include in normal site landscape maintenance	2- to 4-ft depth depending on soil type	Minimum distance of 10 ft down gradient from buildings and foundations recommended	2- to 4-ft clearance above water table/bedrock recommended	Usually not a limitation, but a design consideration.	Permeable soils with infiltration rates > 0.27 inches/hr are recommended. Soil limitations can be overcome with use of underdrains.	Minimum surface area range: 50 to 200 ft². Minimum width 5 to 10 ft. Minimum Length 10 to 20 ft. Minimum depth 2 to 4 ft.	Bioretention
Low requirement	6- to 10-ft depth depending on soil type	Minimum distance of 10 ft down gradient from buildings and foundations recommended	2- to 4-ft clearance above water table/bedrock recommended	Usually not a limitation, but a design consideration. Must locate down gradient of building foundations.	Permeable soils with infiltration rates > 0.27 inches/hr are recommended.	Minimum surface area range: 8 to 20 ft². Minimum width 2 to 4 ft. Minimum Length 4 to 8 ft. Minimum depth 4 to 8 ft.	Dry Well
Low requirement, routine landscape maintenance	Not applicable	Minimum distance of 10 ft down gradient from buildings and foundations recommended	Generally not a constraint.	Usually not a limitation, but a design consideration.	Permeable soils perform better, but soil not a limitation.	Minimum length of 15 to 20 ft.	Filter/Buffer Strip
Low requirement, routine landscape maintenance	Not applicable	Minimum distance of 10 ft down gradient from buildings and foundations recommended	Generally not a constraint.	Swale side slopes: 3:1 or flatter. Longitudinal slope: 1.0% minimum; maximum based on permissible velocities.	Permeable soils provide better hydrologic performance, but soils not a limitation. Selection of type of swale, grassed, infiltration or wet is influenced by soils.	Bottom width: 2 ft minimum, 6 ft maximum	Swales: Grass, Infiltration, Wet
Low requirement	Not applicable	Not a factor	Generally not a constraint.	Usually not a limitation, but a design consideration.	Not a factor	Not a factor	Rain Barrels
				Not a factor	Not a factor	Not a factor	Cistern
Moderate to high	6- to 10-ft depth depending on soil type	Minimum distance of 10 ft down gradient from buildings and foundations recommended	2- to 4-ft clearance required	Usually not a limitation, but a design consideration. Must locate down gradient of building foundations.	Permeable soils with infiltration rates > 0.52 inches/hr are recommended.	Minimum surface area range: 8 to 20 ft². Minimum width 2 to 4 ft. Minimum Length 4 to 8 ft.	Infiltration Trench

Source: UFC 3-210-10, November 2010

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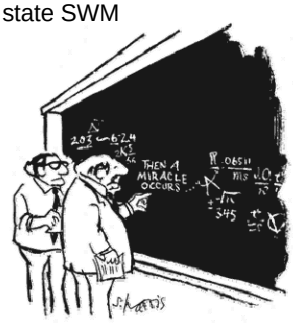
Step 6: Evaluate LID Controls

- Apply Simulation Support to select best stormwater LID BMPs for the site (Army LID Planning Tool).
- Reevaluate site plan to ensure project complies with EISA Section 438 volume requirements and any other federal and state SWM requirements.
- If project does not comply, Repeat Steps 3-6.

(refer to Simulation Support Module 5 of ARMY LID WORKSHOP)



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Incorporate Conventional Controls (if necessary)

- Evaluate supplemental stormwater requirements.
- If after implementing nonstructural and structural LID BMPs to the maximum extent technically feasible (METF), supplemental control is still required (e.g. water quantity), select additional stormwater management practices.
- For example, where flooding problems occur, additional conventional end-of-pipe methods should be considered, such as regional SWM ponds.

Step 7: Recalculate

- Document compliance by refining EISA Section 438 calculations throughout project: LID planning and design is an iterative process.
- Numerous site planning configurations and LID alternatives may need to be evaluated to identify the optimum solutions.
- Emphasize simple and cost-effective LID alternatives. Use a simple hydrologic method (Army LID Planning Tool) to assist in identifying these solutions during planning, prior to detailed design phase.

(refer to Simulation Support Module 5 of ARMY LID WORKSHOP)

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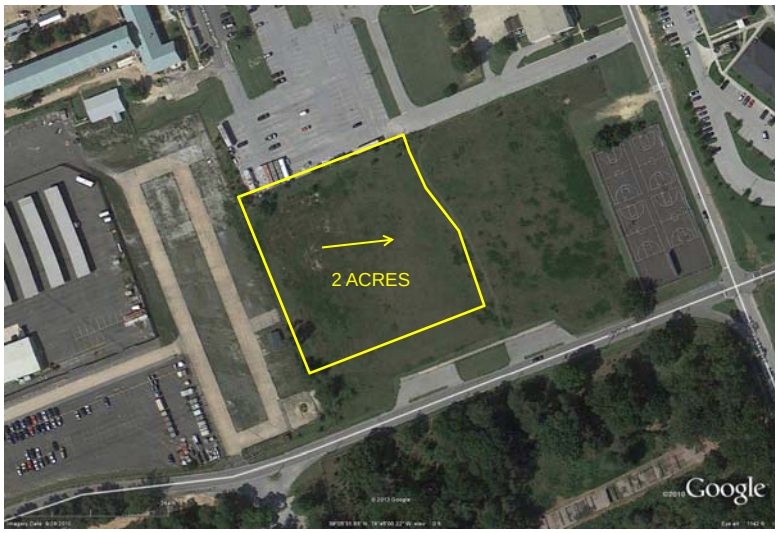
Site Planning Process: Parking Lot Expansion Example



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Parking Lot Expansion Example

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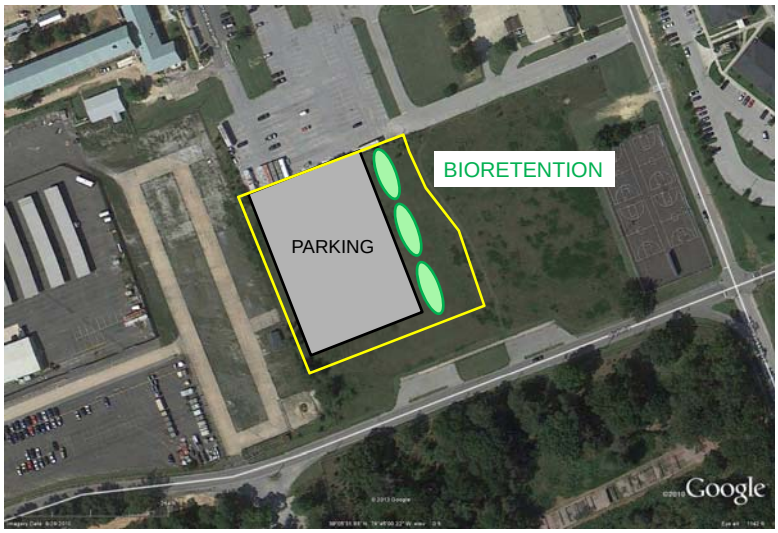
Parking Lot Expansion Example



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Parking Lot Expansion Example

Complying with EISA Section 438 SWM Requirement:

- Site Area: 2 acres
- Site Soils: Sandy Loam (Hydrologic Soil Group B)
- Existing Site: Meadow
- Proposed Site: Pavement and Lawn
- EISA Requirement: Increase in Runoff from Existing to Proposed Condition = 5,946 ft^3
- How to Comply: 7,500 ft^2 of bioretention cells infiltrate 6000 ft^3 of runoff into the soils below in one day

✓ EISA Compliance

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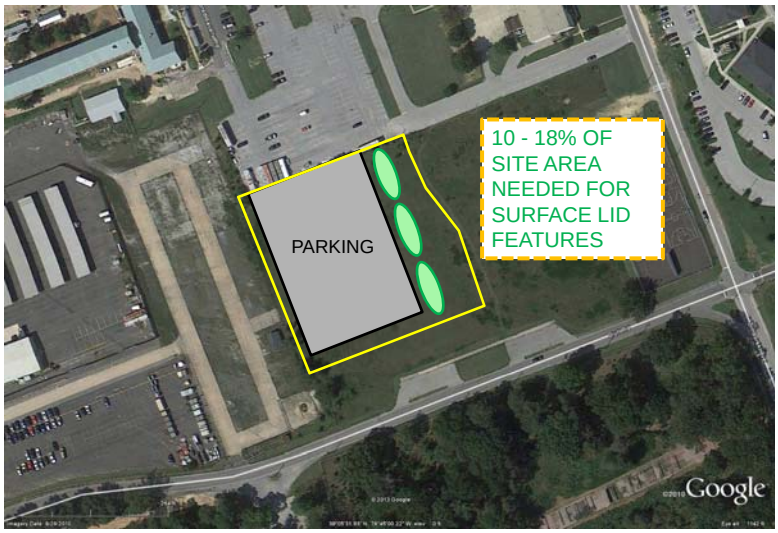
Parking Lot Expansion Example



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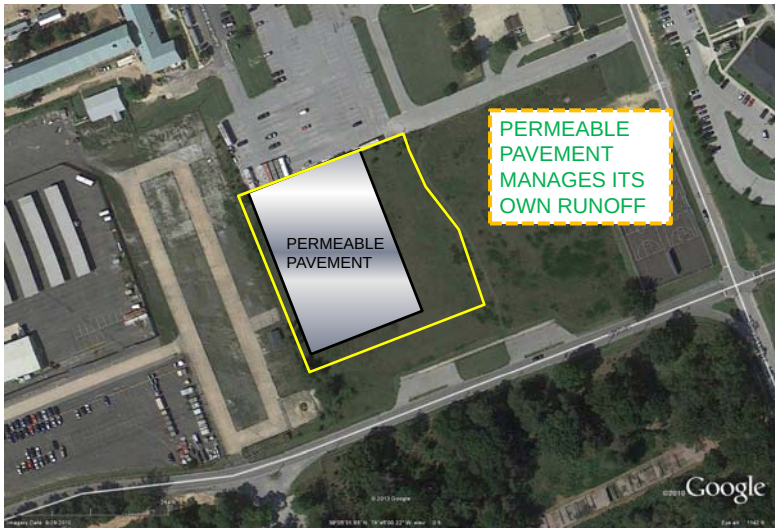
Parking Lot Expansion Example



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Group Exercise Objectives

- Complete one new development and one redevelopment example.
- Establish existing and proposed site conditions (pre- and post-development).
- Use SCS Curve Number Method to calculate required EISA volume to be retained on site (in Army LID Planning Tool).
- Select LID BMPs to satisfy EISA volume requirement.
- Estimate cost to construct LID BMPs.

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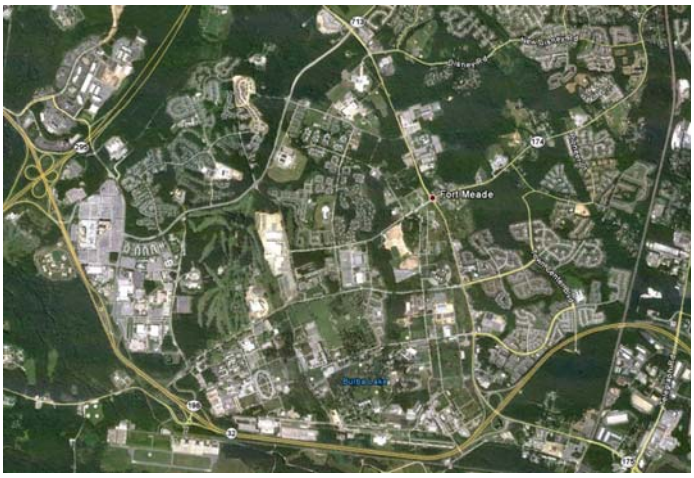
Fort Meade, Maryland

Fort Meade is a United States military post located outside of Baltimore, MD.

Fort Meade, MD, gets 44 inches of rain per year. The number of days with any measurable precipitation is 109.

On average, there are 215 sunny days per year in Fort Meade, MD.

The July high is around 88 ºF. The January low is 24 ºF.



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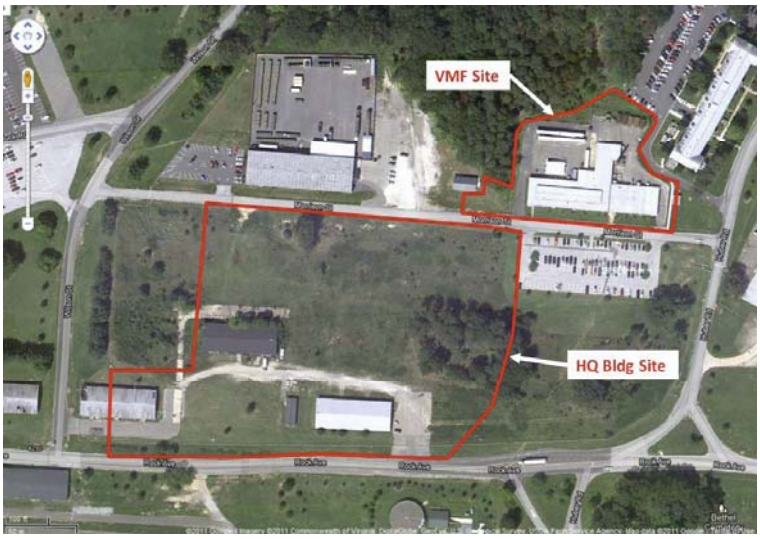
HQ Complex – Fort Meade



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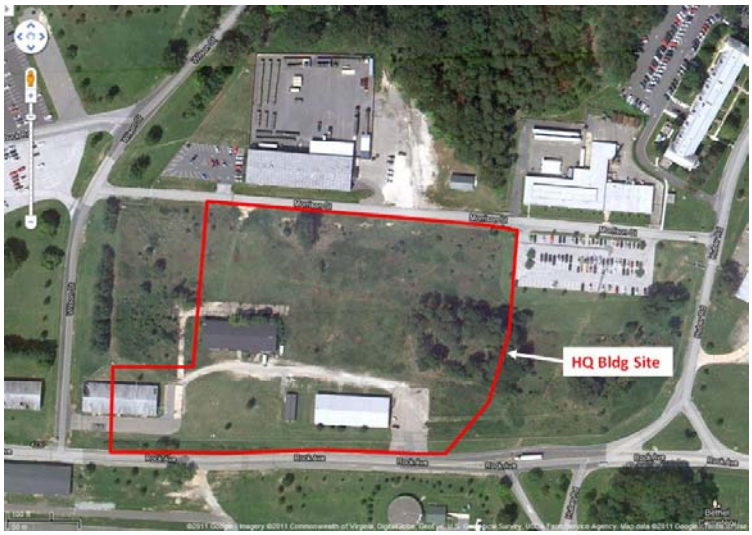
HQ Existing Site



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VMF Existing Site

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Site Planning for LID

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Access Existing Sites

First two steps of Site Planning:

- Step 1 - Site Inventory
  - Land Use
  - Geologic Conditions
  - Soils
  - Hydrology (Drainage Patterns)
  - Topography
  - Natural Resources
  - Facilities Infrastructure and Existing Utilities
- Step 2 - Opportunities and Constraints
  - Preserve Natural Resources (e.g. woods, streams, wetlands)
  - Maintain existing topography

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Questions?

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Access Existing Sites

First two steps of Site Planning:

- Step 1 - Site Inventory
  - Land Use
  - Geologic Conditions
  - Soils
  - Hydrology (Drainage Patterns)
  - Topography
  - Natural Resources
  - Facilities Infrastructure and Existing Utilities
- Step 2 - Opportunities and Constraints
  - Preserve Natural Resources (e.g. woods, streams)
  - Maintain existing topography

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HQ Existing Site Inventory

- New development project
- Existing site is mostly meadow
- Small pocket of mature woods
- Abandoned buildings with associated parking and driveway to be demolished
- No wetlands or streams within the site
- Groundwater not an issue – borings show water table to be at least 15' below ground surface
- Soil Type = HSG "B" Sandy Loam

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HQ Existing Site Inventory

- Site Area = 9.30 ac
- Soil Type = HSG “B”
- Fort Meade 95th Percentile Rainfall = 1.6”
- Existing Land Use Breakdown:

  Meadow = 7.63 ac

  Woods = 0.87 ac

  Impervious (Buildings and Parking) = 0.80 ac

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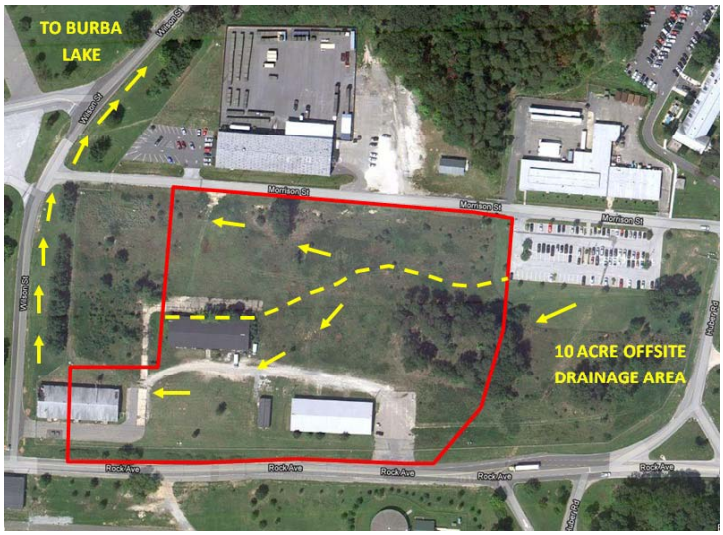
HQ Existing Drainage Paths



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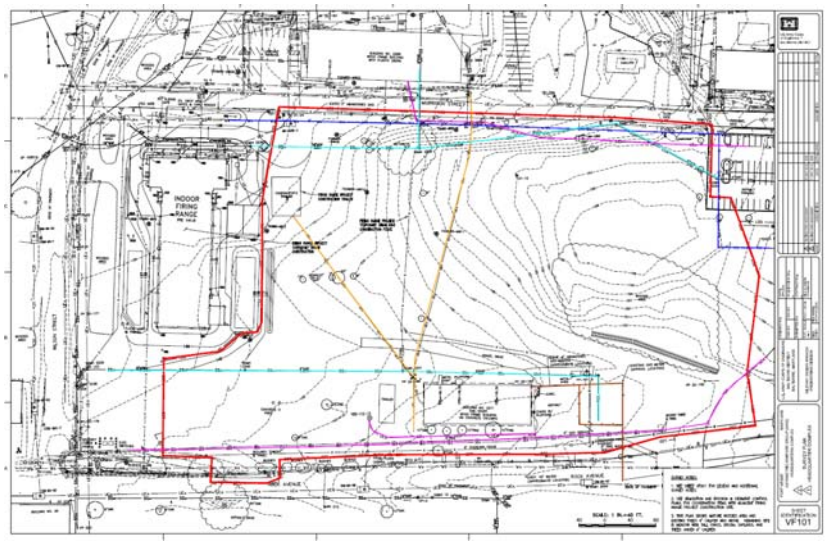
HQ Utilities Infrastructure



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VMF Existing Site Inventory

- Redevelopment project
- Existing site is mostly impervious (building and pavement)
- Site surrounded by mature woods
- Drains to ephemeral stream northwest of site
- Groundwater not an issue – borings show water table to be at least 15’ below ground surface
- Soil Type = HSG “A” Sandy

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VMF Existing Site Inventory

- Site Area = 3.0 ac
- Soil Type = HSG “A”
- Fort Meade 95th Percentile Rainfall = 1.6”
- Existing Land Use Breakdown:

  Maintained Lawn = 0.70 ac

  Impervious (Building) = 0.53 ac

  Impervious (Pavement) = 1.77 ac

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VMF Existing Drainage Paths

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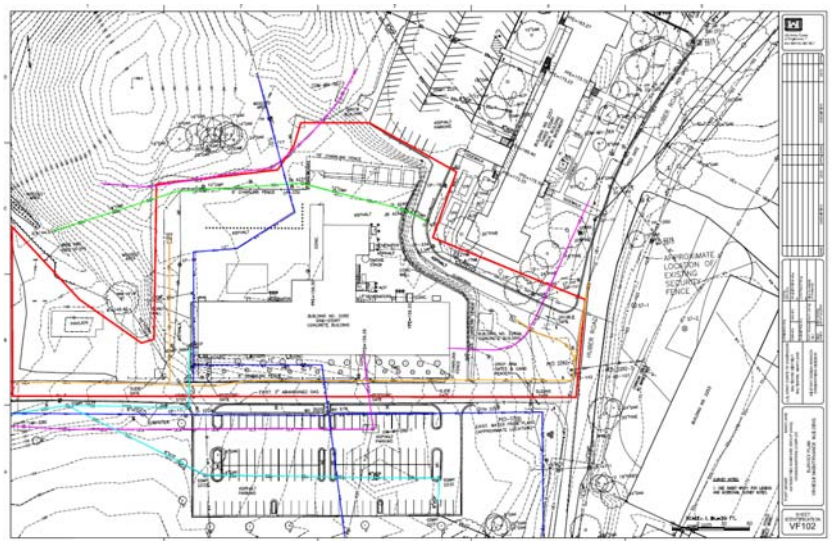
VMF Utilities Infrastructure



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