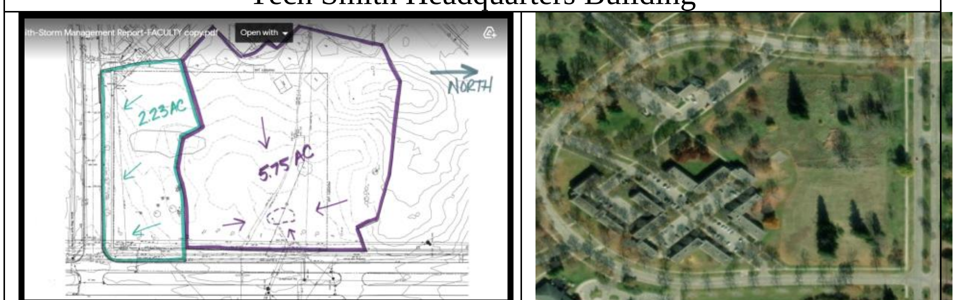
CAPSTONE SENIOR DESIGN PROJECT - HYDROLOGY

This capstone project seeks to engage with the next generation of civil and environmental professionals, foster a dialogue about the need for innovative stormwater management techniques, and showcase the environmental, economic, and social benefits of green infrastructure practices.

Your team has been contracted to design an innovative, sustainable stormwater management system for the proposed Tech Smith ("Project Hedge") site, located at corner of South Harrison Road and Crescent Road within the former Spartan Village development area on the MSU campus.

Tech Smith Headquarters Building



Site location on the campus of Michigan State University

Your design solution must:

- Incorporate green infrastructure practices, individual or grouped (e.g., a treatment train) that manage stormwater.
- Prevent frequent flooding.
- Prevent further deterioration of the Red Cedar River water quality, including during storm events.
- Be realistic and cost effective. The design must be buildable within a reasonable, near-term time frame.
- Be capable of being permitted from a regulatory standpoint.
- Be aesthetically pleasing and fit into the general landscaping of the MSU campus and the existing stormwater system.

Your team is encouraged to consult with local green infrastructure practitioners and/or professional engineers in developing your design. Consulting with community and regional experts will bolster stakeholder engagement and may result in replicable designs that offer solutions to local and regional concerns. Your final project report must include information on the green infrastructure design and performance and should reflect consultation with the facilities planning department to assess project feasibility.

This capstone hydrology / stormwater management design project is part of the overall green infrastructure senior design project that involves structural engineering, transport engineering, geotechnical engineering, pavement engineering, and environmental engineering. Successful implementation of this hydrology project requires close interactions among ALL members on your team.

BACKGROUND

Michigan State University continues to implement its vision of redeveloping the 140-acre Spartan Village into a technology and innovation campus. Recently Michigan's governor and the MSU president were among others who announced the construction of a new headquarters for Tech-Smith, a software development company previously located nearby. The new 62,500 square-foot headquarters is being developed in partnership with the MSU Foundation on approximately 5 acres of land at the corner of South Crescent and Harrison Road.

The University is seeking innovative, proof-of-concept design that examines how green infrastructure could be integrated into the Tech-Smith site to meet multiple environmental, educational, and economic objectives. The development must be consistent with MSU's campus master plan.

	
Runoff contaminated with oil and other debris is washed down a storm drain, where it will feed into local waterbodies.	A "green street" uses practices such as porous pavement and bioretention to capture, infiltrate, and evapotranspire stormwater, preventing contaminated runoff from reaching local waterbodies

Stormwater runoff is a major source of water pollution in urban communities across the United States. Traditionally, stormwater is drained through engineered collection systems, or "gray infrastructure," and discharged into nearby waterbodies. As stormwater moves through the landscape, it transports trash, bacteria, heavy metals, and other pollutants from the urban environment — contaminants that degrade water quality and threaten public health. Stormwater also causes erosion and flooding, damaging habitat, property, and infrastructure. Green infrastructure offers flexible solutions for managing stormwater runoff.

The term “green infrastructure” refers to a variety of practices that restore or mimic natural hydrological processes. While “gray” stormwater infrastructure moves stormwater away from the built environment, green infrastructure uses soils, vegetation, and other media to manage rainwater where it falls — through capture and evapotranspiration. By integrating natural processes into the built environment, green infrastructure provides a wide variety of community benefits, including improving water and air quality, reducing urban heat island effects, creating habitat for pollinators and other wildlife, and providing aesthetic and recreational value. Green infrastructure solutions can also be cheaper to install and maintain than traditional gray infrastructure.

Water pollution associated with stormwater runoff is a growing problem in communities across the country. Communities need planners, designers, engineers, and other professionals to create dynamic, resilient, and affordable solutions for stormwater management. The capstone project invites students to apply their creativity, knowledge, and energy to solve these challenges. Together, regulators, communities, and the next generation of environmental professionals can solve the challenges of stormwater management and protect public health and the environment for all Americans.

The University will:

- Work with students to assess the multiple environmental, economic, and social benefits of green infrastructure solutions over a range of spatial scales and geographic contexts across the country.
- Provide a hands-on, interdisciplinary learning experience for students to gain real-world skills that can be applied to future careers.
- Facilitate stakeholder engagement across college campuses and their surrounding communities to promote green infrastructure practices and forge meaningful connections between students and practitioners

SUBMISSION REQUIREMENTS

Your team must submit the following, which describe your innovative green infrastructure project:

- One (1) Project Narrative
- One (1) Design Board
- One (1) Video Pitch
- One (1) Signed Letter of Support

Submissions should provide detailed information of sufficient quality to enable the judges to evaluate the design based on the challenge’s judging criteria. A description of the design judging criteria begins on page 6 of this document. Submissions should describe overall project goals, how the project fits within the context of the campus or watershed, existing conditions along with the problem to be solved, proposed green infrastructure approaches, and expected outcomes.

Project Narrative

The intent of the project narrative is to provide a summary of your team's approach to meeting the challenge criteria (see Judging section).

- Your team must prepare a project narrative not to exceed eighteen (18) 8.5" x 11" pages (including a cover page, images, graphics, tables, calculations, and references). Any additional pages that exceed the 18-page limit will not be reviewed. Pages should be consecutively numbered with 1" margins, and text should be single-spaced in standard 12-point font. Headings may be larger than 12-point font; text labels for graphics or images may be smaller than 12-point font; page numbers may be outside of the 1" margin.
- The project narrative must include a cover page. The cover page must display the team's name, project title, names and academic majors of team members, and the name and academic department of the team's faculty advisor.
- The project narrative must include a project abstract of no more than 250 words.
- Your team must provide an electronic copy of the project narrative in Adobe Acrobat® PDF format. Instructions on submitting deliverables are provided below. Alternative formats will not be accepted.

Design Board

The design board should:

- Provide a visual understanding of the site context, design elements, and design performance.
- Focus on visual elements and limit the amount of text. The design board should supplement, not duplicate, graphics within the project narrative.
- Include the team's name in the upper right-hand corner and be 24" x 36".
- Include a site plan. Additional elements might include cross sections, conceptual drawings, or graphics representing anticipated benefits.
- Be provided in an electronic copy in Adobe Acrobat® PDF format. Submission instructions are provided below. Alternative formats will not be accepted.

Video Pitch

- Your team must prepare a video pitch about the project not to exceed 3 minutes. Videos longer than 3 minutes will not be viewed.
- Your team should develop a video pitch that is persuasive in illustrating the potential environmental, economic, and social benefits of the project.
- The video pitch could include but is not limited to: a tour of the potential site; discussion of design components; interviews with team members, faculty, or practitioners; or financing options. Content and style are at the discretion of the student team. Creativity and enthusiasm are encouraged and appreciated. Show us what sets your entry apart from the rest.
- Video pitches must be created from original content. Using copyrighted footage without attribution of the original source will result in disqualification. You represent and warrant that the work submitted is your own original work and that it does not infringe upon the intellectual property rights of any other person.

- Your team must upload your video pitch to YouTube or a similar video-sharing website and provide a link with their submission (see submission instructions). Videos should be set as “unlisted” or “private” so that entries cannot be detected by search engines prior to the submission deadline. Once the submission deadline has passed, it’s crucial that your team sets its videos to “public” so judges can access them during their review period. Instructions on how to upload a video on YouTube and how to change a video’s privacy settings on YouTube are available online. The inability to review a video will result in disqualification.

Letter of Support

- The letter of support demonstrates that the team has consulted with the college or university’s facilities planning department to develop a feasible design. The letter of support cannot be written by the team’s faculty advisor. Each team must submit a letter from a member of the college or university’s facilities planning department demonstrating support for the proposed design. If a demonstration project design is located off-site at a nearby school within the community, the letter of support must come from facilities staff at the selected school, school district, or municipal planning department.
- The letter does not count against the 18-page limit of the project narrative. Letters of support are not to exceed two 8.5” x 11” pages. Pages that exceed the limit will not be reviewed.
- The letter must be on appropriate letterhead. Additionally, the letter must be signed by a member of the facilities planning department and include the registration number and project title.
- The letter must be provided in Adobe Acrobat® PDF format. Instructions on submitting project files are provided below. Alternative formats will not be accepted.

ASSESSMENT

Your submissions will be judged on a scale of 0 to 100 and points will be awarded across five criteria:

Judging Criteria

- Performance (30 points)
- Design (30 points)
- Implementation (15 points)
- Communication (15 points)
- Resilience (10 points)

PERFORMANCE (30)

- Does the design effectively use green infrastructure practices to capture and treat stormwater runoff on site (e.g., through infiltration, evapotranspiration, or harvest and reuse) and improve local water quality?

- Is the predicted performance quantified and supported by modeling and calculations? Calculations should include the design storm managed and/or the annual reduction in runoff volume.
- Are additional benefits (water/energy conservation, flood management, heat island reduction…) identified and in any way quantified?
- Does the design reference the appropriate local and/or state design standards?

DESIGN (30)

- Does the design adhere to the requirements specified on page 1?
- Do the design components convey the functionality and value of the design with a cohesive, multi-disciplinary perspective?
- Do visual media and graphics in the design board, project narrative, and video pitch complement one another and give the viewer a cohesive, visual understanding of the design context, elements, and desired performance?
- Did the team collaborate with the university facilities department or external stakeholders to develop a design that is feasible and replicable either locally or regionally? For example, does the proposed project align with local stormwater management requirements?
- Do the selected green infrastructure approaches address multiple campus environmental, social, and economic objectives (e.g., water resource management goals, public health benefits, educational and recreational opportunities)?
- Does the design complement efforts to address areas of environmental, economic, and social need within the broader community or region?
- If applicable, does the design incorporate and complement existing features such as drainage basins, water bodies, circulation routes, or other connective features?
- If applicable, does the design convey a theme for the application of green infrastructure across campus, complement existing master plans, or serve as a model for new long-term planning efforts?
- If applicable, do project components detail how future growth and development will impact the design? Does the design incorporate flexible implementation strategies that allow planning efforts to adapt to changing circumstances over time?

IMPLEMENTATION (15)

- Does the project narrative detail how the design could be implemented/phased over the near-, mid-, and long-term time horizons?
- Are the selected time frames for project implementation reasonable?
- Does the project narrative include a cost estimate for the proposed project?
- Did the team research grants, loans, and other sources of financing capable of covering or supplementing the cost estimate? Information included in the narrative must represent a viable financing path to project construction.
- Does the narrative contain information on how the project will be operated and maintained over time (e.g., maintenance requirements and schedules, sourcing labor, covering costs)?

COMMUNICATION (15)

- Does the project narrative include a description of the overall project goals, project context, existing conditions along with the problem to be solved, proposed green infrastructure approaches, and expected outcomes?
- Are documents well written, error-free, and of sufficient quality to enable judges to evaluate the design?
- Is the video pitch original and creative? Does it illustrate the environmental, economic, and social potential of the project in plain language?
- Does the project contemplate public outreach and education (e.g., examples of signage, infrastructure tours, or other learning opportunities)?
- Did the team forge partnerships and/or identify stakeholders (e.g., university staff, alumni networks, city, county, state, non-profit, private entities) that could help support the proposed project? The purpose of such partnerships or stakeholder involvement could include, but is not limited to, financial support, operations and maintenance, design consultation, or environmental education

RESILIENCE (10)

- Does the design incorporate priorities included in local, state, regional, or national climate resiliency initiatives, sustainability plans, adaptation plans, or climate action plans?
- Where applicable, does the project include regionally appropriate, native vegetation that will provide ecosystem services that integrate the natural and built environments?
- Does the design incorporate elements of stormwater capture and use for non-potable water applications to offset and replace potable water demand?

Guidelines for Quantitative Evaluation

The following table provides examples of metrics or resources that your team may use to document how your project meet these criteria. This information is not required, as not all of it may be relevant to a design. To the extent that this information is relevant, however, quantitative information on the anticipated outcomes of you team's design will be more compelling to the judges than narrative descriptions. If your team opts to present any of the information listed below, you are encouraged to use the suggested units to facilitate the judging process. Your team is also encouraged to describe the methodologies used and provide references, as appropriate. Your design should adhere to appropriate state and local design standards.

Outcomes	Example Metrics and Terminology
Stormwater Management	Reduction in impervious area (sq. ft., %)
	Reduction in directly connected impervious area (sq. ft., %)
	Reduction in runoff depth from existing and/or natural condition (in/year, %, or size of design storm managed)
	Change in annual stormwater pollutant load from existing condition (pounds/acre/year)
	Change in stormwater peak flow from existing and/or natural condition (based on 1-year, 24-hour design storm and expressed as cubic feet/second/acre, %)
Integrated Water Management	Reduction in landscape water requirement (may be attributed to change in plant species or change in irrigation efficiency) (gallons/year, %)
	Reduction in potable water use for irrigation (may be attributed to reduction in

	landscape water requirement or use of captured rainwater or recycled gray water) (gallons/yr., %)
	Reduction in potable water use for indoor uses (gallons/yr., %)
	Annual groundwater recharge (gallons/year)
Other Ecosystem Services	Area of protected or restored soils (acres, sq. ft.)
	Area of protected or restored native plant communities (acres, sq. ft.)
	Increase in canopy cover (10 years after installation) (% of site area)
	Increase in roof area shaded by vegetation (% of roof area)
	Increase in hardscape area (roads, sidewalks, parking lots, courtyards) shaded by vegetation (% of hardscape area)
	Map showing locations of windbreak vegetation relative to buildings
	Reduction in building electricity consumption due to vegetation roof insulation/evapotranspiration or tree shading (Kwhs, %)
	Air pollutant removal by trees, also known as dry deposition (lbs/yr)
	Carbon dioxide (CO_2) sequestered by new trees (lbs/year)
	Change in plant diversity (plant list before and after project; use of native plants; use of minimum input minimum maintenance plants; % of plants in specified category)
	Change in pollinator and/or wildlife diversity (list of species supported by plants before and after project)
Financial Viability	Total Project Cost Estimate: an itemized estimate of the project cost based on the projected period of construction. Operations and maintenance: Appropriate operation and maintenance activities ensure that green infrastructure will continue to function properly and yield expected water quality and environmental benefits, protect public safety, meet legal standards, and protect communities' financial investments. The cost of maintaining infrastructure over time is an important consideration when planning a project. Useful life: The period of service for an infrastructure asset. Projects should have funding sufficient to operate and maintain assets throughout their period of service. For more information on sources of funding for green infrastructure visit: EPA's Green Infrastructure Program https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities EPA's Water Infrastructure Finance and Resiliency Center https://www.epa.gov/waterfinancecenter EPA's Water Finance Clearinghouse https://ofmpub.epa.gov/apex/wfc/f?p=165:1