Introduction:

There is no possible way to pinpoint which direction technology will develop. New technologies will become developed and realized, and with it, new requirements to fuel the bottomless desire progress. The nature of the scientific field is that of change; from the discovery of new knowledge, the fluctuation of resource requirements, and the continuous physical changes a laboratory must undertake in response these. As for the question of what drives the quest for further scientific progress is unimportant, especially for those tasked with designing the facilities that will put forth these future developments. The nature of this architectural field requires architects to design in such a way as to facilitate the evolution of the laboratory - to consider the unpredictability of scientific growth in a probabilistic world. As a designer of such facilities; you mustn't design for the future, as the future will one day become the past. Rather, you must design to allow occupants to have the flexibility and freedom to change the design as they consider the future. While the laboratories within this facility are designed with the current future technological trends for oil spill response in mind, the facility is designed to allow the future occupants to change each laboratory's design with relative ease as future technologies become available.

It is important to understand what this facility represents in the work done inside. At its core, this facility is an environmental protection research and response laboratory. The personnel are working in this building to do everything they can to ensure that environmental damage is kept to a minimal. Thus it is our job as designers to make sure that this building has as little of an environmental impact as possible. The irony of environmental protection taking base in a large concrete building is not lost on the project, however we can do our best to design keeping the environment in mind with the technology we have at our disposal.

Eco-toxicology

Concerned with the toxic effects of chemical and physical agents on living organisms, especially on populations and communities within defined ecosystems, and includes the transfer pathways of those agents and their integration with the environment. This laboratory will, initially, be testing the environmental effects of chemical compounds (pre-existing and developed in this facility) used to respond to oil spills.

Possible Types of Test Done in Lab:

- Acute Tests: Short term exposure tests (hours-days) of immediately effected biological matter
- Chronic Tests: Long term exposure tests (weeks, months, years) of future long lasting effects on the generation of new biological matter
- Effluent Testing: Demonstrating environmental compliance of waste treatment operations (biodegradability)
- Toxicity Identification/Reduction Evaluation (TI/REs)
- Mold and Algae Growth Testing: Plant growth using effected water
- Bioaccumulation: Accumulation of chemical compound in organisms over long term exposure
- Sediment Testing (dirt, mud, rock)

Space Requirements:

- Bio-Vestibule: Entry helps control airflow, acts as a barrier against cross contamination. Should have a sink.
- Main Lab Space
- Bio-Waste/Decontamination
- Storage Room: Secure storage units, refrigerators, freezers, long term experiment storage
- Biosafety level 2

Possible Equipment Required:

- Multiple refrigerators and freezers (-20°C,-70°C, and -135°C)
- Centrifuges
- Sink (with hot, cold, and reverse osmosis)
- Water baths
- Balances
- Bio-safety cabinets
- Flammable and non-flammable chemical storage lockers
- Chemical fume hoods
- Ovens
- Autoclave
- Medical pathological waste (MPW) storage
- Knee hole space (For various types of MPWs)
- Non-automatic defrost freezers
- Sequencers
- Protein synthesizers
- Thermocyclers for PCR reactions
- Pipette equipment
- Incubators
- Shakers
- Microscopes
- Electron Microscope
- Algal growth chamber
- Turbidimeters
- Viscometers
- pH measurement

Chemical Dynamics:

A branch of physical chemistry that seeks to explain time-dependent phenomena, such as energy transfer and chemical reactions, in terms of the detailed motion of the nuclei and electrons that constitute the system. Similar to Eco-toxicology, this lab will initially be testing for environmental effects of chemical compounds used to respond to oil spills with special attention to chemical reactions with compounds.

Possible Areas of Study Conducted in Lab:

- Transition State Theory: The most successful and widely employed theoretical approach for studying reaction rates involving species that are undergoing reaction at or near thermal-equilibrium conditions
- Variational Transition State Theory: Within the TST expression for the rate constant of a bimolecular reaction, krate = kT/h (qAB*/V)/{(qA/V)(qB/V)}or of a unimolecular reaction, krate = kT/h{(qA*/V)/(qA/V)}, the height (E*) of the barrier on the potential energy surface appears in the TS species' partition function qAB* or qA*, respectively.
- Ambient Water Quality Testing: Absorption effects on water column
- Toxicity Identification/Reduction Evaluation (TI/REs)
- Bioaccumulation: Accumulation of chemical compound in organisms over long term exposure

Space Requirements:

- Bio Vestibule: Entry helps control airflow, acts as a barrier against cross contamination. Should have a sink.
- Main Lab Space
- Bio-Waste/Decontamination
- Storage Room: Secure storage units, refrigerators, freezers, long term experiment storage
- Larger electrical demands, ranging from 110V-480V
- High ceilings for specialized equipment
- Complex machinery that may require direct piped services such as cryogenic gases, nitrogen, water, DWV, vacuum, compressed air, and gas
- Biosafety level 2

Possible Equipment Required:

- Multiple refrigerators and freezers (-20℃,-70℃, and -135℃)
- Centrifuges
- Sink (with hot, cold, and reverse osmosis)
- Balances
- Biosafety cabinets
- Flammable and non-flammable chemical storage lockers
- Chemical fume hoods
- Ovens
- Autoclave
- Medical pathological waste (MPW) storage
- Kneehole space (For various types of MPWs)
- Non-automatic defrost freezers
- Sequencers
- Protein synthesizers
- Thermocyclers for PCR reactions
- Pipette equipment
- Robotic analysis equipment
- Shakers
- Microscopes
- Electron Microscope

Development of Detection and Monitoring Technology (robotics lab):

This Laboratory will focus on the development and testing of remotely operated vehicles (ROVs) and monitoring equipment which will be used to analyze and evaluate of the dynamic behavior of components and systems used for the oil and mineral extraction process in order to develop improved response systems to oil pipe failures. This lab will work much closer with the coast guard than the other laboratories to test and utilize new detection and evaluation technologies in the field. This laboratory will function using three types of laboratories: a wet lab, a dry lab, and an assembly lab. Initially the robotic wet lab will primarily focus on the development and deployment of new and more eco-friendly variants of chemical compounds termed "Herders" by response units. A herder is a chemical compound made from amphiphiles possessing both hydrophilic and lipophilic properties. When sprayed onto the water surrounding the oil spill the herder forms a mono-molecular layer on the water surface, reducing the air - sea surface tension and causing the oil slick to retract into a thick mass.

Possible Types of Test Done in Lab:

- Composition analysis: Determining the chemical quality, identity, composition and impurities, with molecular structure elucidation and chemical structure confirmation
- Trace contamination detection: Trace and ultra-trace metals analysis of complex substance matrices, chemical residue testing, Extractable and leachable studies
- Failure analysis: Testing for reasons of chemical structure failure
- Chemical Regulatory Compliance Testing: Ensuring that chemicals are compliant with regulations
- Synthesis Process: Eliminate differences in molecular types, distribute the chemicals by matching sources and sinks, eliminate differences in composition, eliminate differences in phase or pressure, integrate tasks

Space Requirements:

- Bio-Vestibule: Should have positive air pressure relative to surrounding space. Entry helps control airflow, acts as a barrier against cross contamination. Should have a sink.
- Main Lab Space
- Bio-Waste/Decontamination
- Storage Room: Secure storage units, refrigerators, freezers, long term experiment storage
- Air filtration systems
- Biosafety level 2

Possible Equipment Required:

- Chromatography columns
- Refractometers
- Spectrometers
- Multiple refrigerators and freezers (-20°C,-70°C, and -135°C)
- Centrifuges
- Sink (with hot, cold, and reverse osmosis)
- Balances
- Flammable and non-flammable chemical storage lockers
- Chemical fume hoods
- Ovens
- Non-automatic defrost freezers
- Sequencers
- Protein synthesizers
- Thermocyclers for PCR reactions
- Pipette equipment
- Shakers
- Microscopes

Space Requirements For All Wet Labs:

- Epoxy paint for walls
- Seamless, chemical resistant, vinyl flooring with mylar finish
- Easy access to shut off valves (above all connections)
- Terminal reheat system with pre-filters and after filters for 90% efficiency
- Positive air pressure relative to other spaces with no return air from laboratory to other spaces(for hazardous/harmful chemicals)
- Utility Connections: vacuum, pneumatic, natural gas, O2 and CO2, distilled water, power
- Toxic gas monitors
- Eye wash stations
- Dry fire suppression systems
- Movable sliding power outlets from above
- Fail safe redundant backup systems
- Uninterrupted power supply (UPS)
- Emergency power supply
- Interstitial space
- Key locks
- Brushed stainless steel kick plates

Interstitial Space:

Intermediate space located between regular-use floors, commonly located in hospitals and laboratory-type buildings to allow space for the mechanical systems of the building. By providing this space, laboratory and hospital rooms may be easily rearranged throughout their lifecycles and therefore reduce lifecycle cost.

- Ceiling utility drop with quick connections and blanks for future gases
- Should be organised in zones: Structural zone, Branch distribution zone (for utilities distributed through the floor such as waste), main distribution zone, branch distribution zone (for utilities distributed through ceiling), Lateral distribution zone (electrical mostly)

Dry Lab:

Using computer modeling and bioinformatics this laboratory will run simulation tests on interactions of chemical compounds and molecules using data collected from wet lab experiments. This laboratory will run quantum mechanical and molecular simulations at the atomic level. This will allow scientists to save resources by running thousands of molecular interactions every minute. Using computer simulations, scientists can study molecular mechanics at the atomic level, predicting the structures of proteins eliminating trial and error. Primarily, this is the space that scientists will be constantly returning to either with new data for simulations or for the design of new compounds. This is the 'drawing board'. Being in the field of oil spill response, the facility will be working almost exclusively with wet materials, which allows for the dry labs to be converted into one computer lab to serve as the main hub for molecular and compound design. In this space, all the scientists from all three different lab types can collaborate with each other providing different inputs and approaches from their varied background educations. This is also where the robotic design scientists will design the remotely operated vehicles (ROVs) and monitoring equipment which will then be sent to the robotic assembly lab and robotic wet lab respectively.

Space Requirements:

- Much larger electrical demands, ranging from 500-1000 W per computer
- Separated server room with double redundant power back up systems, dry fire suppression system, redundant memory backup system, air conditioned to be no more than 26°C (78.8°F), key card locked, and 2 modules (22') in size.
- A connected open office space for collaboration and paper work
- Surge protectors

Equipment Required:

- Computer monitors
- Large computer server room with back-up hard drives

Special Function Laboratories:

Flume Lab:

The flume lab is a large open bay laboratory containing different types of man-made flumes for the purposes of experimentation and simulation with water flow. This laboratory can be used to study how different chemical compounds behave in different water based environments, the role of bedrock channels in long-term landscape evolution and erosional mechanisms.

Electron Microscope:

More specifically, a scanning transmission electron microscope (STEM) is specialized microscope that uses a beam of accelerated electrons to focus on a sample specimen. A STEM microscope can achieve resolution exceeding 50pm (pictometers) in dark-field imaging mode and clear visible magnification of up to roughly 10,000,000x. For comparison, a helium atom has a diameter of 62 pictometres. An electron microscope can be used to view the 3D structure of materials and biological tissues, observe proteins, characterize and analyze organic materials, obtain quantitative lithotype and porosity characteristics of the environment, and much more. This tool is a staple in scientific research for its diverse range of applications.

Space Requirements:

- Preparation room outside of microscope room to allow the samples to be decontaminated and prepped for observation, to receive imaging information from the microscope, and to store liquid nitrogen for chilling.
- 1 module in size (11')
- Biosafety level 2
- Ceiling height of no less than 10'
- Isolated KEEL slab for vibrational control
- Key card locked
- Relative negative pressure to corridor

Program Organization:

The goal of the program organization is to successfully integrate the program data into a well organized, coordination of spatial concepts that address the functional needs, project parameters, efficient work flows and spatial specific equipment of the laboratory environment. Planning should address the adequacy of space for its intended use, occupant comfort, and ergonomics. The laboratory plan should have an emphasis on openness (to as much of an extent as possible without compromising safety standards) to encourage coordination and collaboration among the scientific staff. A laboratory environment is host to personnel who spend large amounts of time within a highly technical workplace, thus, the laboratory plan should promote the physical and psychological well being of its occupants. Strategies used in this facility include: large amounts of natural light, open lab spaces, combined lab spaces, shared storage spaces (while still maintaining cross contamination border), bench style lunch room tables, and the use of "micro kitchens". Micro-kitchens encourage personnel to snack more often, leaving the lab environment for more breaks which promotes the 'casual collision' between colleagues. This strategy is used by large companies such as Google that rely on the creativity of its employees. Using the Westgate West study model, which shaped the modern understanding of how physical space directly correlates to the formation of friendships, the lunchroom and computer dry lab became the heart of the organizational plan. The placement and orientation of the other laboratory spaces became expressions of their necessary relationships with each other with an emphasis on collaboration.

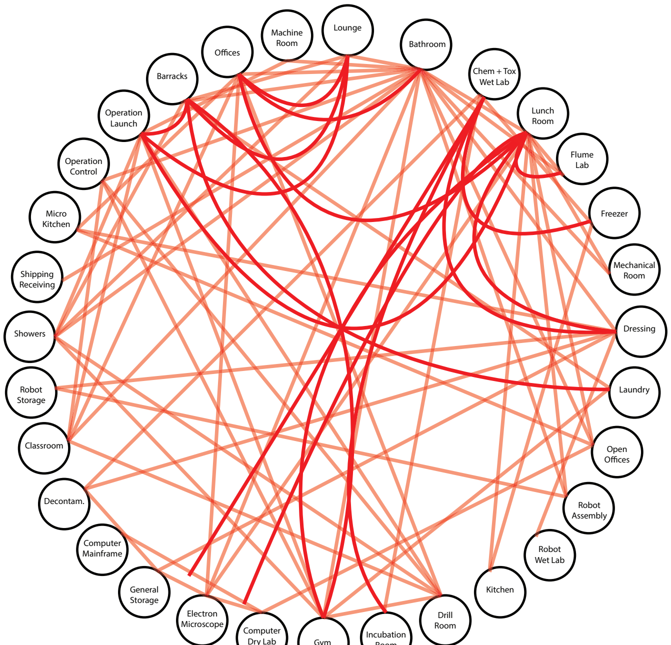


Diagram depicting possible movement between spaces

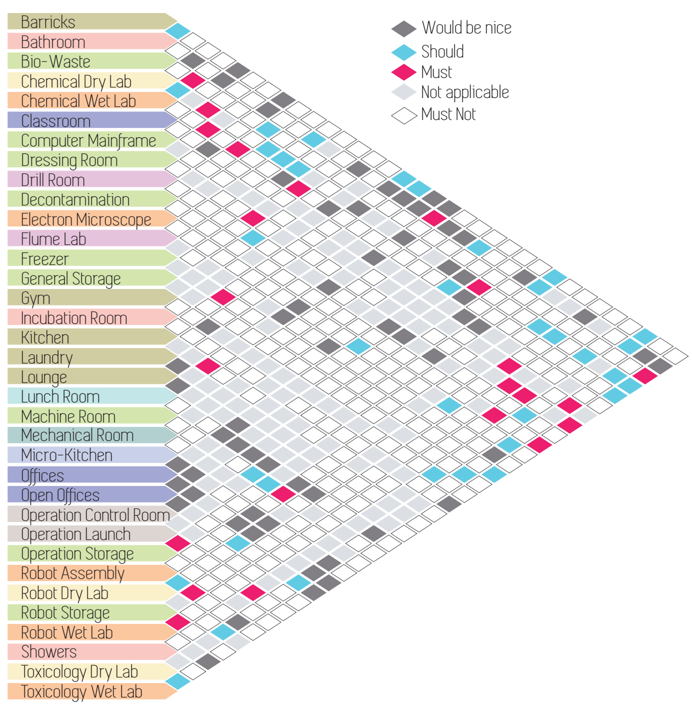
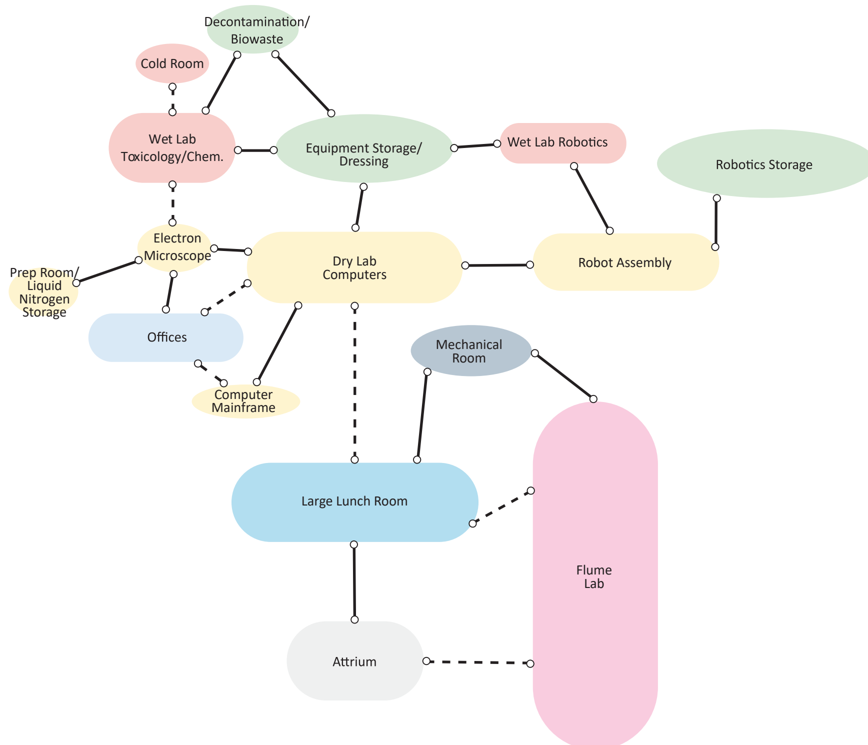
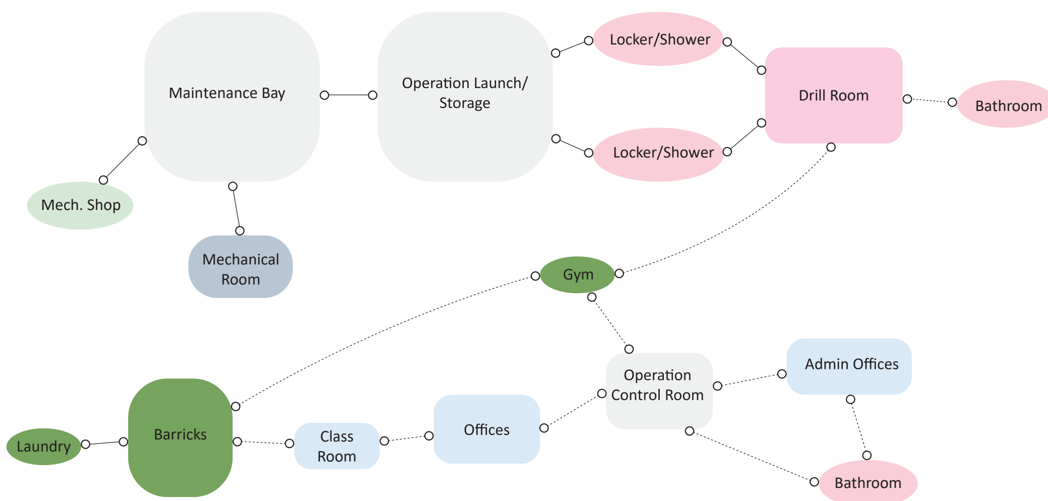


Diagram depicting possible different room configurations





Bubble diagrams showing initial floor space organization

New Materials Used in Building Construction:

Hempcrete:

Hempcrete is a eco-friendly material composed of a combination of renewable hemp hurds and a natural lime hydraulic binder. It is a firm, cement like material whose main application for this facility lies in its self insulating properties. Hempcrete acts as a thermal mass as well as an insulating material. This unique combination of properties allows it to regulate the temperature and humidity of a building by slowly releasing built up heat as its surroundings cool, resulting in massive energy savings. This material has the ability to absorb carbon from the air, as much as 130kg of CO_2 per meter cubed. The carbon trapped in the hemp offsets both the carbon emitted from hemp production and the residual carbon from the lime production which then releases only the oxygen, making hempcrete one of the only carbon-negative materials in the world. This unique property of the material allows it to have the added benefit of being used for natural ventilation. Hempcrete has a unique pore structure that gives the material an excellent ability to store and release moisture. Hemp-lime is capable of rapid liquid transfer, high moisture retention and high water vapor permeability, all of which act to avoid condensation, and manage the internal environment to retain comfortable conditions

Facts and Figures:

- Density: 275kg/m^3 (15% of concrete)
- Compressive strength: 1 mpa
- Thermal conductivity: 0.06-0.07 W/m k
- U-value: 0.17 W/m^2 k
- Heat capacity: 1500-1700 J/kg
- Acoustic absorption 0.69 NRC
- Fire rating: 1 hr BS EN 1365-1:1999
- Airtightness: 2m^3/m^2 per hr at 50pa
- Euroclass E fire rating

KBI Flexi-crete:

Flexi-crete is a porous recycled paver material to be used as a substitute to other paving materials. For this facility, Flexi-crete will be used in the parking lot. Composed of recycled passenger tires, crushed stone and a urethane binding agent manufactured by KBI. It is an extremely flexible and extremely durable material, lasting an average of 20-30 years without replacement. One of the most important things to consider when selecting a paving material for a snowy climate is determining whether the city uses salt or sand. It may seem minimal but it has a massive impact on the integrity of the pavement. Flexi-crete has a high porosity rate which gives it a horizontal flow rate of 96.4 inches per hour and a vertical drainage rate of 341 inches per hour making it safe for salting. It is also extremely resistant to freeze-thaw damage, showing no cracks or damage after 300 cycles of ASTM C 666/C/666M testing. It reduces dissolved nitrates and phosphates by 88%. It's high flexibility allows it to withstand up to 250 psi without permanent deformation or damage.

Facts and Figures:

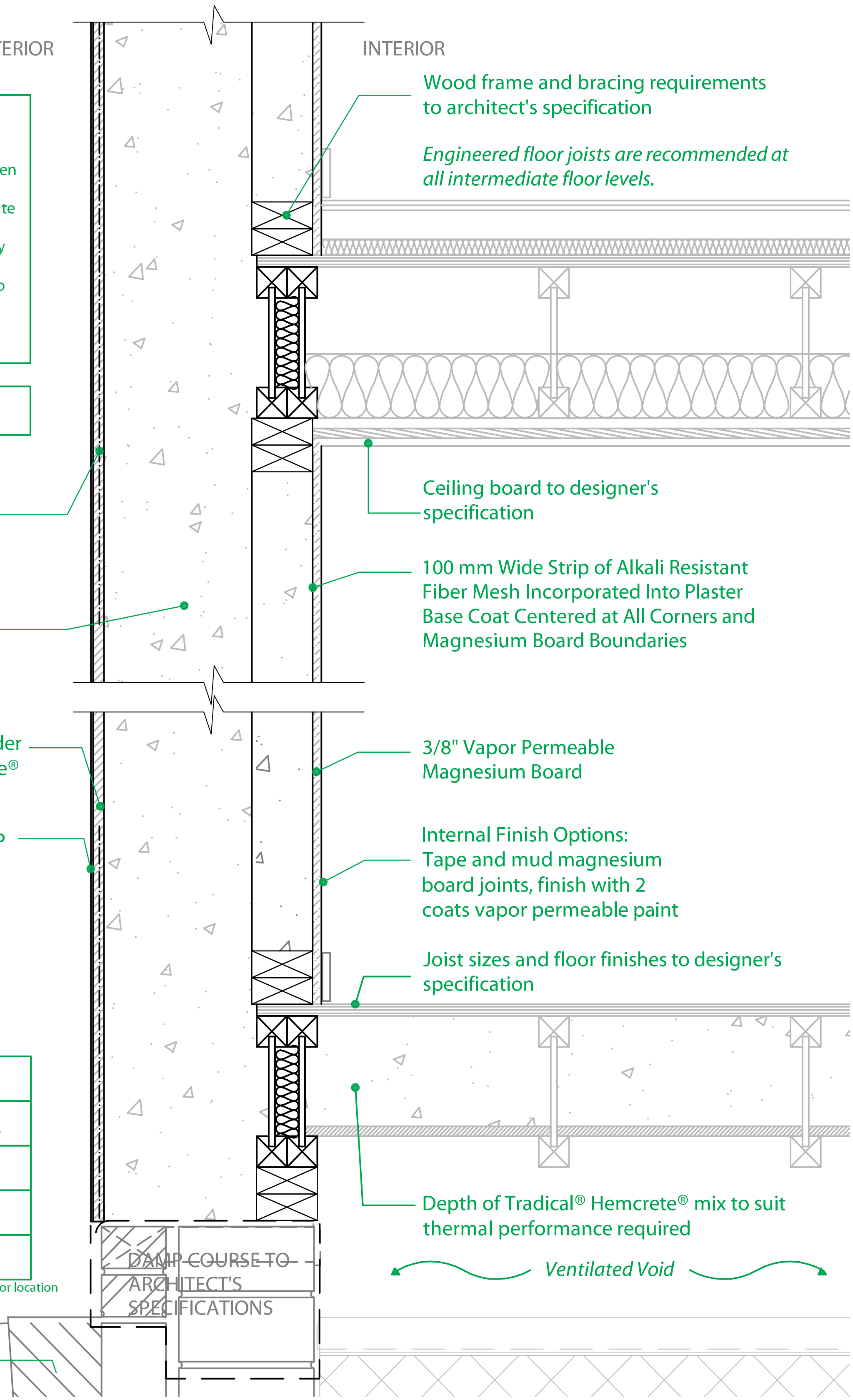
- ADA compliant
- 23% porosity
- Allows up to ~3,000 gallons of water to drain per hour
- Safe for plowing
- Replenishes groundwater resources
- Reduces city water run-off by 79%

Details are INDICATIVE ONLY and need to be made project specific.

While reasonable care has been taken to ensure that the information included in this drawing was accurate at the time of issue, we reserve the right to change specifications at any time. Final detailing remains the responsibility of the designer due to site & client specific requirements.

Do not scale from this drawing.

Drawing to be read in conjunction with all standard series drawings



All structural fasteners to be non-ferrous, any galvanized fasteners to be painted with red oxide primer or bitumen paint.

Wall thickness (in.) Vs. R-value (ft²·°F·h/Btu)		
Approx. Wall Thickness	Hemcrete Thickness	Overall R-Value
11.25	10	26*
13.25	12	30*
16.25	15	35*

*Static R-value not adjusted for thermal mass or location

Example of typical installation of Hempcrete insulation

The Parking Lot:

Parking lots pose a number of different negative effects on the environment. From robbing natural areas of rainwater to replenish aquifers, to contributing to the urban heat island effect, it is environmentally irresponsible to passively designate an area as a parking lot without any forethought. With the use of KBI Flexi-crete offering many environmental benefits over conventional asphalt, we are one step closer to being more eco-friendly but this is not enough for a research and response facility. This facility's parking lot can feature several different low impact development practices that also allow scientists to monitor the local environment such as: rain gardens, bioretention areas, and infiltration trenches.

These sub-drain systems can help to remove pollutants, replenish groundwater resources and reduce the risk of flooding and stream channel erosion by providing opportunities to infiltrate storm water and snow melt runoff. This also allows scientists to measure local water quality, flow rates, volumes and water temperature. Rain, city runoff, and snow melt water can all be filtered by; passing through the gravel in the infiltration trenches while on its way to; the rain gardens where it will be filtered and cleansed a second time by the soils and plants; before finally being released back into the water table.