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Additional Materials

To: Chris Balestra, Planner
Town of Ithaca

October 12, 2018

Chris,

Enclosed please find responses to questions from the Planning Board from their October 2nd meeting. Included in this package you will find:

1. Responses to questions about the stormwater management plan
2. Responses to questions about energy

If you need anything else, please do not hesitate to ask. As always, thank you for your advice and assistance.

Kimberly Michaels
Principal

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Stormwater (pages 75-77)

A board member asked for more information about the management of stormwater, particularly as it relates to the portion of the run-off which will be discharged to Beebe Lake, a fifth order stream.

The stormwater management strategy is described in detail on pages 75-77.

The stormwater management systems are designed to and will be required to comply with NYSDEC regulations.

As described in the SEQR materials, a portion of the site run-off (first-year student site) will discharge to Beebe Lake, a 5th order stream. The NYSDEC stormwater design standards and general permit allow quantity increases to run-off on sites that discharge to a fifth order stream or larger. The primary reason for this is that the peak flows in these larger streams occur much later in time than the peak discharge from the site. Due to the large offset in time-to-peak between the site and the creek, increases in discharge from the site will not increase the peak flow rates in the larger stream. Detention of runoff on the site would tend to bring the two peaks closer together. A good illustration of the concept is the recent flooding in the Carolinas. Localized flooding happened during the storm event, however, the large generalized flood events (associated with stream bank overtopping), occurred as much as two to three days later than the storm. Peak discharges from individual sites typically occur during very short-duration high-intensity storms that are local to the site, whereas peak flows in the larger creek typically occur during more general wide-spread storm events. In other words, a 100-year storm event on the site will likely not coincide with a 100-year storm event for the stream.

Compared to the 128-square mile Fall Creek watershed, the project will disturb about 25 acres or 0.04 square miles which equates to about 0.03%, three one-hundredths of a percent of the watershed.

Furthermore, The 10-, 50-, 100- and 500-year peaks for the Fall Creek watershed at Cayuga Lake have been estimated by FEMA to be 5,920 cubic feet per second (cfs), 8,950 cfs, 10,430 cfs and 14,400 cfs, respectively. Based on the current hydrologic calculations our civil engineer estimates the peak rates of runoff discharging to Fall Creek directly from subareas four and five will increase by approximately seven cfs, from 65 cfs to 72 cfs, during the 10-year storm, and approximately eight cfs, from 143 cfs to 151 cfs, during the 100-year storm. It is not expected that the quantity or timing of the volumes of run-off from this project will damage downstream structures.

Relative to water quality, the project will employ bioretention filter practices throughout the site to provide treatment for runoff from over 7.5 acres of the impervious areas on the site. The practices target higher polluting parking areas, loading docks and vehicular drives but will also treat runoff from lower polluting pedestrian paths and roofs. In addition to quality treatment, the bioretention filters will also provide runoff reduction volume through infiltration, evaporation and transpiration. The infiltration provided by the practices will increase the recharge of groundwater on the site and help to reduce the volumes of runoff especially during smaller storm events. To increase the amounts of runoff reduction volume provided, most of the filter practices are oversized relative to the minimum required for quality treatment.

Energy Impacts

A request to contextualize 42 Billion BTU of Energy a year. How many homes in Tompkins County is that equivalent to?

The energy study by Taitem Engineers (Table 11, page 205 of the SEQR document) lists the NCRE energy use for heating, hot water, cooling and electricity to be 42,445 MMBtus per year.

The Tompkins County Energy Roadmap, (March 2016 Tompkins County Planning Department), estimates the annual residential energy use in Tompkins County at 34 MMBtu per person and 91 MMBtu per household.

Thus, the energy use as estimated for the NCRE residential facilities (which included residences, social spaces, dining facilities, and other residential amenities for 2000 students) is equivalent to the following:

- The average residential use of 1248 persons in Tompkins County
- The average residential use of 466 households in Tompkins County

A request to explain the physical realities of and imbedded energy involved in the additional infrastructure necessary to use heat pumps for the project. Cornell was asked to estimate the "embedded carbon emissions" for an "optional design" that would utilize heat pumps for heating NCRE buildings.

The calculation of embedded carbon emissions is not included in the standard NYSDEC guidance on GHG emissions calculations for proposed projects under SEQR, which is generally focused on site-specific impacts. Thus, there is no NYS SEQR guidance or standard for such calculations in those guidance documents. To provide a reasonable calculation, Cornell utilized the following assumptions:

- The general arrangement and equipment space allocation for heat pumps is estimated based on a scaled-up version of the systems used in Cornell's recent construction at the Bloomberg Center building in NYC. This facility was an all-electric building that used ground source heat pumps. However, the central plant can be connected to a cooling tower such that the choice of air or ground source are both possible for this arrangement.
- The GHG emissions calculations were based on the on-line embedded GHG emissions calculator found at this URL: http://buildcarbonneutral.org/ . This is the calculator referenced in the original Taitem report and used by Taitem as a check for embedded carbon impacts described in the original proposed project submittal.

Calculations

The Bloomberg Center at Cornell NYC Tech is used as a proxy for this estimate. Heat pump system sizing is based on peak heating load.

For the Bloomberg Center, the modeled peak heating load was approximately 4,320 MBH. The total mechanical and associated electrical room space required for the heat pump equipment was about 1800 square feet (~24 x 50 room plus ~600 SF cooling tower). This was a rather "tight" mechanical room (in terms of physical space).

For the NCRE, the modeled peak heating load is about 19,000 MBH, or about 4.4 times the heat load (NYC is more temperate and the building was smaller). While the NYC mechanical space was very tight, some modest economy of scale is assumed. Thus, the total building and cooling tower space is estimated to be as follows:

- For a ground source (geothermal exchange) heat pump solution, the required additional building space would approximately scale up – to about 1,800 x 4 = 7,200 square feet.
- An air source heat pump solution also must account for the lower coefficient of performance (COP) of the equipment. From the manufacturer's data, the COP for creating our 130°F design temperature using exchange with a design low temperature of 0°F would be less than half (~1.7 versus ~3.4 for 55°F ground temperature). Therefore, either a resistance heating override (COP = 1.0), or significantly oversized units or more modular units would be needed to meet peak demand, which occurs on the coldest day. For the purpose of this calculation only, it is assumed the design is to oversize modular units by a factor of 2 (and use resistance heating supplement) to represent this loss in performance, such that the system will require twice the space of a ground source heat pump solution. Thus, for the purpose of the calculations we assume space needs in this case would be approximately 14,400 square feet.

Using this basic data, the on-line calculator is used to estimate the embedded emissions, as shown in table below. A cut and paste of the on-line calculator is included at the end of the section.

Table 1: Embedded Emissions Estimates for Facilities with Heat Pumps

Type of Heat Pump	Building Square Feet	(Additional) Estimated Embedded Energy for Heat Pump Space
Ground Source	7,200	375 metric tons CO_2
Air Source	14,400	185 metric tons CO_2

Impacts acknowledged but not calculated

The calculation above only considered embedded energy for building facilities to house the heat pump systems. Other potential impacts for this alternate include the following:

- Ground source heat pumps (GSHPs) require a well field. Bloomberg Center required 80 vertical well bores to provide for peak and seasonal heating load. The Cornell site may provide more or less thermal capacity based on soil types, subsurface temperatures, and similar factors. Scaling up proportionally based on peak load, it is assumed that approximately 352 boreholes would be required for this project. Since a hole spacing of 20' x 20' is required to mitigate thermal impacts between wells, this would extend construction impacts over an additional land use of about 140,000 square feet (3.2 acres).

- The installation of the GSHP boreholes (typically about 500 feet deep) would typically require about one drill rig day per hole (i.e., 352 days with 1 drill rig or 176 days with 2 rigs, etc.). Drill rigs are typically diesel-driven (direct source of emissions), noisy, and result in significant short-term impacts to local groundwater (in NYC, the subsurface water was not fresh water but saline intrusion from the East River, an estuary of the Atlantic Ocean). Based on Cornell's experience in NYC the borehole field alone would add over $7,000,000 to the project cost. **These environmental, social, and fiscal impacts** have not been assessed.
- Heat pump systems require the use of refrigerants, many of which are potent GHG chemicals. Some have GHG potentials that are thousands of times more potent than CO_2[1] Although efforts are underway to develop and require refrigerants with less potent GHG emissions, refrigerant leakage remains a significant GHG concern[2, 3] **GHG totals here do not include estimates of fugitive refrigerant emissions.**
- Heat pumps of this scale require significant electrical power at peak. For air source heat pumps at peak load, assuming a COP near 1 on the coldest day of the year (i.e., resistance heating override), the delivery of 19,000 MBH of heat (peak load as calculated by the project engineer) could require a peak electrical load of 5.6 MW. **Whether connected to Cornell electric or the grid, this peak would likely require local capacity upgrades.** A well-designed ground source heat pump system will have a lower peak electrical load (approximately 2 MW), but this will still more than double the existing NCRE modeled peak electrical load and may also impact existing infrastructure.

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[1] https://www.epa.gov/sites/production/files/2015-07/documents/fugitiveemissions.pdf
[2] http://www.greenhotelier.org/wp-content/uploads/2016/03/Greenhouse-gas-emissions-from-refrigerantsfinal.pdf
[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/394851/fgas-rac7-alternatives.pdf

Source Documentation (cut & paste of calculator results from referenced calculator website)

Result 1: Ground Source Heat Pump Building (not including well field)

Approximate net embodied CO_2 for this project is **184 metric tons.**

Your Entries

Total Square Feet	7,200
Stories Above Grade	1
Stories Below Grade	0
System Type	mixed
Ecoregion	Eastern temperate forest
Existing Vegetation Type	Previously Developed
Installed Vegetation Type	Shrubland
Landscape Disturbed (SF)	10,000
Landscape Installed (SF)	2,800

Construction Carbon Calculator formula version 0.03.5, last updated 2007.10.11. These results are an approximation. Your actual carbon footprint may vary. See assumptions for more information.

Result 2: Air Source Heat Pump Building

Approximate net embodied CO_2 for this project is **375 metric tons**.

Your Entries

Total Square Feet	14,400
Stories Above Grade	1
Stories Below Grade	0
System Type	mixed
Ecoregion	Northwestern forested mountains
Existing Vegetation Type	Previously Developed
Installed Vegetation Type	Shrubland
Landscape Disturbed (SF)	18,000
Landscape Installed (SF)	3,600

Construction Carbon Calculator formula version 0.03.5, last updated 2007.10.11. These results are an approximation. Your actual carbon footprint may vary. See assumptions for more information.