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**CONSTRUCTION PROJECTS COMMITTEE**  
**THURSDAY, APRIL 24, 2008**  
**NASHUA HIGH NORTH LECTURE HALL**  
**6:00 PM**

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A meeting of the Construction Projects Committee was held at Nashua High North on **Thursday, April 24, 2008**. Alderman McCarthy called the meeting to order at **6:10 p.m.**

Present: Alderman McCarthy, Alderman Tabacsko, Mr. Kelley, Mr. Hallowell

Also Present: Mr. Smith, Mr. Vaughan, Mr., Mosher, Alderman Teeboom, Alderman Flynn

Also Present: Mr. Jeff Harrison, Engineer – Turner Building Science, Mr. DuBois – Harvey Construction

***Discussion of HVAC Project – Responses to Questions***

**Mr. Harrison**

Went through PowerPoint presentation that illustrated several different geothermal systems. They all work best in different areas. The design that would be used in Nashua is the closed loop design, which has lots of variations. Every 100 feet you go down, the water gets about 1 degree warmer with this design. There is a large variation between the designs of cost vs. efficiency. The cost to install a lot of these systems doesn't change a whole lot, but the benefits of going the last few yards to hybrid gives a significant return on investment.

When we did our first analysis of what we could do for Nashua based on our contract, it was to provide a replacement HVAC system for the building. We first looked at the air quality in the building and what we wanted to accomplish. We looked at in-kind replacement and getting up to code. The next one was a system doing heating only, without any air conditioning. The next was what it would cost to add air conditioning to the system. The cost advantage of operation based on using the geothermal hybrid as the energy source in place of fossil fuels, allows you to be able to offer heating and air conditioning at a lesser cost than heating alone.

*Unidentified speaker asked several questions with no microphone. Not audible enough to transcribe.*

**Alderman McCarthy**

How many days a year could we anticipate using just the solar?

**Mr. Harrison**

I believe it's only about 20% of the days in the heating season that it's operating.

**Alderman McCarthy**

For the rest of it, what percentage would we be able to keep the operating temperature up to 50 degrees by using solar?

**Mr. Harrison**

The solar does a good job of running throughout the year the way we size it, so it always stays up there.

**Alderman McCarthy**

But there are days when we're not going to have enough sunlight, correct?

**Mr. Harrison**

There are 2 ways to do the solar. We can take the solar energy when it's available and store it in a tank to meter it out when we want it. And we size the tank large enough to coast through those periods so we don't drop the water temperature below 60 degrees in the tank.

**Alderman McCarthy**

So we'd have a substantial tank that we'd that up on warm days, and then mix that with what we're circulating through the wells on colder days and get a fairly constant temperature of what flows through the system... it that right?

**Mr. Harrison**

Right, and that's one of the things we would engineer... the balance of how much of a tank that takes to coast through those periods. We use weather data that models the real world for this area. Another option to the tank is to use the ground itself as a storage medium, although that's not as effective. The first big bang for the buck you'll get is going with geothermal only. The next step is to add solar and storing it in the ground. That gives you more capital cost and a better life cycle cost, but gives you a little longer payback period. The third step is to add solar storage, which has a better 25-year life cycle cost.

*Unidentified speaker asked several questions with no microphone. Not audible enough to transcribe.*

**Mr. Harrison**

I think at this point we need to just judge the geothermal and the solar on its merit to provide cost effective heating to the district, and then proceed onto more detailed design to try to meet your target of your available budget.

**Alderman McCarthy**

I think what the committee is struggling with, is that we're trying to make a decision on life cycle cost, and we have a 2 by 2 matrix of cost and savings and we have diagonal boxes filled in the other two not, which makes it difficult to make a comparison in either column. I think we're trying to understand if we have a simple solar system just to lift the well water temperature and get us to 50 degrees, what does that cost and what does that save us? If we have a more complex system that also replaces geothermal on 20% of the days, what does that cost and what does that save us? And I haven't seen those answers yet.

**Mr. Smith**

Harvey and Turner have been working on the solar piece of this, and actually we have a spreadsheet right off the press that has a very simple solar system. Can you please talk to this Mr. DuBois?

**Mr. DuBois**

When we first looked at this we had about 210 panels, an underground storage tank and some internal tanks. At an intermediate point, that was downsized to about 125 panels. In a discussion with Jeff the other day, I think what he's referencing here on a \$250,000 cost is to reduce the panels to 75. I apologize for getting various numbers, but the design has fluctuated through discussions and options. It might make some sense Jeff, to spend a little time on the schematic that we started with.

**Alderman McCarthy**

We don't know if the ground water is static or if it moves. If we're dumping heat into the wells from the solar and the ground water is actually moving, we're not really storing it... we're heating downstream essentially.

**Mr. Harrison**

That's correct. With the tank option, if the ground water moves it enhances the system. Without the tank option it detracts from the system.

**Alderman McCarthy**

And we don't know that until we sink a well and pump heat out of it for a year or two and see how it behaves.

**Mr. Harrison**

Correct... it would be an unknown.

**Alderman Teeboom**

Looking at this chart, it looks like the difference between two options is \$1 million. If I read this correctly, we save \$1 million over 25 years?

**Mr. Harrison**

Yes, that's correct.

**Alderman Teeboom**

So between the 2 systems we're saving \$40,000 a year.

**Mr. Harrison**

That's the life cycle costs that includes maintenance, equipment replacements and total cost to operate and keep the system running.

**Alderman Teeboom**

And that's going to have to justify the expense.

**Alderman McCarthy**

What do you mean that has to justify the expense? The \$40,000 a year is after amortizing financing of the construction, after paying for maintenance and fuel costs, etc.

**Alderman Teeboom**

Is that correct? So this takes into account all costs of the system including the financing?

**Mr. Harrison**

Yes.

**Alderman Teeboom**

And this includes the \$23 million cost for the system?

**Mr. Harrison**

No, it makes for the difference in cost between the base and geothermal case.

**Alderman Teeboom**

What's the difference in that cost?

**Mr. Harrison**

I'm not sure what figures are being used at this point.

**Alderman Teeboom**

Well you've got to use something if this includes the cost and we know what the figures are.

**Alderman McCarthy**

This includes the cost differences between doing geothermal and doing boiler replacements. There is still the issue that needs to be resolved about how much other work we're doing and whether we're replacing piping and ceilings, replacing unit ventilators and associated casework.

**Alderman Teeboom**

So is this based on the \$8 million baseline that Turner came up with?

**Mr. Harrison**

It's based on the baseline, yes. I'm not sure of the amount.

**Alderman Teeboom**

There was a baseline of \$8 million. Shawn, do you want to back that up?

**Mr. Smith**

\$8 million for 3 schools.

**Alderman Teeboom**

\$8 million divided by 3. Is this specific to our schools, or is this a universal chart?

**Mr. Harrison**

This chart was from the study of the one building that was to be the first in a series of 3. This was the actual recommendation for that building.

**Alderman Teeboom**

So is that the original \$8 million study?

**Alderman McCarthy**

I don't know that it includes all of the costs, but they are the same in all 3 cases so the delta doesn't change.

**Alderman Teeboom**

There was an original study done by Turner a few years ago that didn't include all those costs.

**Alderman McCarthy**

This is bigger than the \$8 million for 3 schools, but does not include the work that is common to all 3 options.

**Mr. Harrison**

This was just to evaluate the merit of the different types of systems in relation to each other, assuming that all the other work would be equal.

**Alderman Teeboom**

Well the \$40,000 is not a trivial amount of savings. It's not clear to me what the investment is on this.

**Alderman McCarthy**

What you're seeing there is the difference in investment between the 2 systems. There is other work that is anticipated to be done as part of the project, but that is simply an add-on to all 3 options and therefore doesn't change the deltas between them. So no matter what we choose to do at the back end of the project for window replacement, case work, pipe replacements... it's the same in all 3 cases and we save about \$40,000 in that school which probably translates to \$120,000+ for all 3 schools when we're all done.

**Alderman Teeboom**

So is this the one that takes the \$18 million investment for 3 schools?

**Mr. Hallowell**

It's \$4.5 million per school, so multiply it by 3.

**Alderman Teeboom**

What's the investment cost from which the life cycle cost is based? It's a very simple question.

**Mr. Harrison**

The life cycle cost is based on the cost to install each system... each one has a different cost, and includes all cost of maintaining the system and the money to install that system, the fuel to operate it, etc. Those costs are all wrapped into the total cost of ownership of each system.

**Alderman McCarthy**

And my guess is that this is basically on the system plan and does not include what it costs to do the per classroom work that we anticipated to be needed.

**Alderman Teeboom**

So if I remember right, the investment cost of the basic cost of the geothermal system provided by Turner and Harvey was \$18 million... before we had stuff added to it. Is that correct?

**Mr. DuBois**

No, that's not correct. \$18 is the hard cost including roofing, casement replacement, ceiling tile replacement, removing the old system, fixing the boiler room, etc. There were a lot of things that went into that. That ramped up to \$23 when you added what we call soft costs... engineering, moving cost, insurances, everything from the city's side of the equation, not construction costs. I think what you're looking at here is Fairground's life cycle cost, which is the initial cost of the system based on Turner's original numbers including fuel, maintenance, etc. to derive a delta between each system.

**Alderman Teeboom**

And that initial investment cost, I think was estimated at \$8.5 million for 3 schools. That's almost \$3 million a school. Is that the number?

**Mr. Harrison**

I'm just making the assumption. I didn't put this together. So, you're looking at \$4.5 million, which is the cost of the system, operating cost and maintenance cost.

**Mr. Smith**

I think we're talking about the mechanical system. The geothermal solar system was around \$8.5 million for 3 schools.

**Alderman McCarthy**

The problem is, you don't have a system. You have the central components of a system at that price. There is still a tremendous amount of project work left to do to heat the building itself, which is not included in that life cycle cost.

**Alderman Teeboom**

That is my point. If you're going to do a lifecycle cost, it has to include all the costs.

**Alderman McCarthy**

But that has nothing to do with the comparison. If we included all those other project costs it would only change the labeling on the Y-axis. The relative size of the bars would stay the same.

**Alderman Teeboom**

Okay, let's just move on.

**Mr. Hallowell**

For other geothermal systems, does anyone else use a peaking boiler?

**Mr. Harrison**

Yes, they're most common. Anything smaller than 20,000 sq. ft., a peaking boiler is waste of money. Anything larger, a peaking boiler starts to make a lot of sense. If you didn't have it, the system would have to be sized twice as large. And doubling the system size for 15% of the hours of operation doesn't make sense economically.

**Alderman Teeboom**

Was that system designed based on empty classrooms?

**Mr. Harrison**

In the heating mode, it's assumed that the building is empty. In the air conditioning mode, it's assumed that it's full.

**Alderman Teeboom**

I'm told that's the worst case. When the building is filled with kids, it creates a huge amount of BTU's.

**Mr. Harrison**

When we calculate the energy consumption, it accounts for building filled and unfilled periods. When we size the system, we have to size it so that it's heated when there's nobody there. So it depends on what you're doing and what you want for an answer. If you're figuring how much energy is going to be consumed, we take into account the passive solar gain coming in the windows, the heat from lights and people and that is subtracted off from fuel use in the calculation. To pick the equipment size, we have to do that when the building is empty.

**Alderman Teeboom**

Why do you have to heat it when it's empty? The heat pump's off.

**Mr. Harrison**

If you don't heat it when it's empty, you'll need a much longer recovery cycle to warm it back up when you turn it back on and you'll need even a larger system.

**Mr. Hallowell**

If you factored in 500 kids and 50 adults how many fewer wells would we be taking about?

**Mr. Harrison**

It wouldn't change the peak design load, but only the annual fuel consumption.

**Mr. Hallowell**

Even if you did it for the peak load, how much does it really affect the calculation?

**Mr. Harrison**

I have no idea. Every student is 250 BTU's.

**Mr. Hallowell**

If you're going to do the solar storage tank, I'm assuming it is sitting on a roof?

**Mr. Harrison**

No, underground.

**Mr. Hallowell**

So the only impact to the roof is the solar panels themselves?

**Mr. Harrison**

Correct.

**Mr. Vaughan**

When you say storage in the ground, are you referring back to like the porter shroud thing where it bleeds off...

**Mr. Harrison**

No, what we do is take the solar energy and we put it directly into the return water that's in the closed loop going to the wells. So it just carries the solar heat to the ground but stays in the closed loop. It's the coldest water, so it can capture the most solar energy.

**Mr. Hallowell**

If you're doing that in the summer where you didn't have the tank, is there a way to shut off the feedback?

**Mr. Harrison**

If the ground got too warm, we would just shut the solar down and let it stall. They don't have any problem sitting idle.

**Mr. Vaughan**

So with the peaking boilers, if we had a particular cold winter, we would be looking at higher utility costs and not a freezing school.

**Mr. Harrison**

Correct.

**Alderman Teeboom**

There was a question last time about this being a very expensive system, even without some of the extra stuff. Can you address your answer in some detail?

**Mr. Harrison**

Well, again I think the point of what I've been trying to say tonight is that not all geothermal systems are created equal. The BTU's per dollar provided by each geothermal system is unique based on the pumping cost, the size of the pumps, the size of the pipes, etc. The solar portion contributes significantly to making the system more efficient to provide a better life cycle cost. The design we have to date is again, a 1-page schematic intended to establish an order of magnitude cost estimate for 3 different systems to establish which avenue would provide the best life cycle to the school: in kind replacement; heating only with a ventilation system; heating & air conditioning with a ventilation system or a ventilation system with an alternative energy source. So the analysis showed that the best life cycle cost for the district was to follow the avenue of alternative energy because it allowed you install a good ventilation system with air conditioning at a lower operating cost than even in kind replacement.

**Alderman McCarthy**

I don't think that's the intent of the question and I'd like to clarify it. I don't think it's a question that you can actually answer. I think it's a question for the committee. As I understand the proposal that's referenced in there, it involves not installing air handlers and a displaced air system, but rather installing new unit ventilators with exposed piping in each classroom and a central water loop that is geothermal. Is that your understanding, Mr. Smith?

**Mr. Smith**

Yes.

**Alderman McCarthy**

The basic tenet of replacing the unit ventilators and going with exposed piping, is certainly one that is not acceptable to me, and I don't think based on what we've done with other projects, to the rest of the committee. So I think the discussion we've had is around what is best alternative to use in the heat plant itself to produce the loop water that is used to heat the building. There is a separate discussion that has to be had about whether we are doing displacement air through the building and replacing unit ventilators, or whether we're doing something else in place. And I think that's outside the scope of what you're doing on what's the best alternative for the water loop itself in terms of geothermal plans.

**Mr. Harrison**

Right, and when we first started looking at the project, we were faced with a building that had poor inner air quality due to insufficient outdoor air that the existing unit ventilators could provide. One of the parts of the class I teach is about unit ventilators and what they represent as far as how much maintenance they are. Each one is just a hole in the wall waiting to leak and cause problems. Each one is a noisy, rattling class distraction and is a system that is best left in the past. It just doesn't lend itself to energy recovery. That was the first premise when we started our design was to start with a good ventilation system and go from there.

**Alderman McCarthy**

What percentage of our energy will we actually be recapturing and recycling with the air handlers in the system that we just looked at?

**Mr. Harrison**

Probably about 40%.

**Alderman McCarthy**

With individual unit ventilators, I assume we don't reclaim heat at all and that we'd bring in all fresh air. So we'd lose 40% right off the top.

**Mr. Harrison**

That's correct.

**Alderman Teeboom**

The original proposal he's keeping the unit ventilators.

**Mr. Harrison**

The base case represented in that chart is in kind replacement of everything that's here.

**Alderman Teeboom**

I'm just referring to question #14. Mr. McCarthy tried to answer something about a proposal that's not proposed.

**Alderman McCarthy**

My understanding of what Mr. Maedl proposed was addition in place of another identical set of unit ventilators with exposed piping to avoid replacement of ceiling tiles on the casework.

**Alderman Teeboom**

I don't think your understanding is correct.

**Alderman McCarthy**

I believe I do.

**Alderman Teeboom**

I don't think you do.

**Alderman McCarthy**

Mr. Smith, is that your understanding of the proposal?

**Mr. Smith**

That was my understanding, yes.

**Alderman Teeboom**

Well, since you haven't heard Mr. Maedl's proposal, and I have it right in front of me, that's not what he said. Nobody recommends...

**Alderman McCarthy**

Where are the heat pumps in Mr. Maedl's proposal that actually heat the room air in the building?

**Alderman Teeboom**

He's not using the existing ventilators.

**Alderman McCarthy**

Right, he's placing a heat pump in each classroom in the school, which takes in fresh air from the outside, heats in to temperature and dispenses it. That is a unit ventilator.

**Mr. Harrison**

Those are those pesky hotel units that you always want to turn off because they're so noisy.

**Alderman Teeboom**

But those are different.

**Mr. Harrison**

No, those are the same.

**Alderman Teeboom**

That's not what we're talking about here.

**Mr. Harrison**

Yes it is what we're talking about.

**Alderman Teeboom**

To be honest, I haven't heard Mr. Maedl's proposal presented. I figured you'd study his proposal, because you got a copy of it. Did you look at his proposal?

**Mr. Harrison**

We were hired to provide a new heating/ventilating system for the school. The first premise of that is that in order to provide a good indoor air environment with opportunity for energy recovery, central systems are the state-of-the-art that everyone is installing, because of the inefficiencies of the unit ventilators.

**Alderman McCarthy**

If I drop the 40% heat that I can reclaim from the building, what happens to the blue and the green bar in the upper number?

**Mr. Harrison**

The difference between the red and the blue is in kind replacement vs. an air handler. The additional savings from the energy recovery pays for the ductwork and then some, which the red and the blue are showing.

**Alderman McCarthy**

Right. And if we were not doing heat recovery, I suspect that the \$40,000 a year savings that we anticipate becomes much smaller if not negative.

**Mr. Harrison**

It would become negative, because you still have to pay for the system if you put it in.

**Alderman McCarthy**

So your opinion is that that system as proposed is actually more expensive than simply replacing with a conventional system at this point?

**Mr. Harrison**

Yes, because of the opportunity for energy recovery. It's a significant amount of dollars.

**Alderman Teeboom**

On that same chart up there, I have not seen a life cycle analysis that shows all the pieces. You see \$40,000 savings per year per school for 25 years. And after that I guess the savings are greater.

**Alderman McCarthy**

There is an updated spreadsheet that we've requested that I don't think we've seen.

**Alderman Teeboom**

A simplified spreadsheet... there should be a fairly straightforward way to look at that. This is the investment cost and here's the cost to maintain the system...

**Alderman McCarthy**

We had that from a long time ago and there are some adjustments that need to be made and we don't have that yet.

**Alderman Teeboom**

If I have to invest \$18 million to save \$120,000 per year and I finally see that investment paid off in 25 years, I may not want to do that.

**Alderman McCarthy**

But you're paying less every year. It's like a car dealer telling you that I can put you in a Chevy for \$5,000 a year or I can put you in a Cadillac for \$4,500 even though the price of the Cadillac is more expensive, which one would you take? The cash flow is lower on a yearly basis starting with year one with the geothermal system than if we do replacement in kind.

**Alderman Teeboom**

That's what I need to see. Because to bond \$18 million, it's going to cost about \$1.5 million a year.

**Mr. Harrison**

Again, at that point you're not comparing the systems anymore, you're trying to make the geothermal system pay for other renovations to the building.

**Alderman Teeboom**

That's another thing I don't know. I still don't quite know what the geothermal costs and the other costs are that have nothing to do with geothermal. And there's an argument about what other changes we want to make?

**Alderman McCarthy**

Yes, and I'd like to schedule another Construction Committee meeting in a week or so if that fits into the schedule. And I'll talk to Mr. Smith about what we'd like to see in that spreadsheet. I'd like to concentrate at that meeting on the details of what needs to be done outside of just the heat plant itself and what we're looking at in terms of the costs of doing the actual project work in terms of installing duct work, air handlers, etc. Let's try to set up a meeting where we can talk about that when we don't have JSSBC back to back.

**Mr. Hallowell**

Could you give me a little bit of your background of how you came to be in this position?

**Mr. Harrison**

I spent my first 10 years in the business as a consulting engineer for one of the bigger firms in Portland, working mostly in the paper industry. Following that I spend 15 running my own consultant business doing mechanical, electrical and plumbing. And I spend the last 5 years with Turner principally doing forensic engineering, studying failed systems. That's how this geothermal system has evolved. We started putting in meters to see how geothermals operated. We installed one geothermal well with sensors all the way down to well to actually see how the ground temperature dropped. So we put a lot of study time in to see how these worked and what these differences make.

**Alderman Teeboom**

Are you a certified geothermal designer?

**Mr. Harrison**

I am.

**Mr. Vaughan**

So, this is certainly not your first project. How many have you guys put together for schools or buildings similar to us?

**Mr. Harrison**

I can't even count the numerous ones that are at the level you're at. I've got maybe 10 different operating systems that are providing good results at this time with all various configurations.

**Alderman Teeboom**

What's the situation on having Mr. Maedl speak to the committee?

**Alderman McCarthy**

I'll have administration set it up.

Alderman Tabacsko moved to adjourn. **So voted at 7:45 p.m.**

*Submitted by Jacki Waters*