

Dave,

Thanks for your engaged, cogent questions and concerns about municipal broadband. If you put these same questions to Loveland's broadband consultants, I'd like to know what they say.

Let me begin with the last paragraph of your email, where you write: *And regardless of what the citizens say they "want", I believe that we as elected officials and experienced citizens such as yourself need to be diligent and smart in thoroughly researching the issue and give them what is "best".*

The purpose of my broadband memorandum was precisely to help Council become better informed, so that your choices *can* be diligent and smart. If the proposition doesn't hold up to an objective, dispassionate examination, then Loveland shouldn't do it.

But the voters who overrode SB-152 aren't spoiled kids who just "want" something unreasonable. Internet access has become an essential feature of everyday life for the father or mother looking for work, and the companies that might hire them; for their children in school or college, and the instructors who provide up-to-date electronic texts and online courses; for small businesses, people who work from home, and the global customers who might buy from them; for people who fall ill, and their doctors looking at CAT scans that are ten times as information-dense as they were just a decade ago; and for our own City government, to provide better service to citizens more effectively and efficiently.

So I say, let's start with an intent to really try to make this work. Maybe in the end it can't be done, but let's work the problem thoughtfully and creatively. Eyes open to risks, for sure, but that 83% vote mandates a constructive effort to find a path, or make one. Unexpected things often occur to help people who are determined to succeed.

*1. Risk - this is probably my biggest concern. You have addressed this issue in your review but I am still not convinced. The risk concern involves several aspects of the project - these are listed below.*

The risks here are not unforeseeable, random events that can only be passively endured. They can be analyzed. We can work and plan to reduce their likelihood, and mitigate their impact should they occur.

The costs and consequences of *not* proceeding must also be part of the assessment. Properly understood, these are also risks. It's just that we don't usually think of them that way; they are the conditions in place, so nobody gets "blamed" when they come to pass with near certainty.

If nothing changes, Lovelanders will continue to pay every month a considerably higher price than necessary for poor and patchy broadband services. I mentioned in my memo that Lovelanders could save \$1.4 million a year per \$10 of price differential between commercial providers vs. municipal service.

Longmont suggests that NextLight subscribers save an additional \$50 per month by "unbundling" TV and entertainment services, subscribing via Internet to only the services they really want. The sooner that happens, the more money will be saved. Unbundling will happen anyway, sooner or later, but it won't do much good for subscribers with inadequate bandwidth (such as many DSL subscribers).

In an optimistic case, that's \$720/year saved per subscriber. Maybe it's \$500 on average because some subscribers will be lazy about unbundling. Still, if we have 11,200 subscribers that would be \$5.6 million

per year, unnecessarily flowing out of our community. I don't want to argue about details, but there is an implicit, large number here that shouldn't be ignored when weighing risks and benefits.

And that says nothing about other lost opportunities that would be tangible benefits if the project succeeds. **In my opinion, the path forward is to analyze, understand, and mitigate risks where possible. But it's essential to recognize doing nothing is also a kind of risk. My colleague Richard Toftness feels so strongly about this that he says doing nothing is not an option.**

2. *Changes in technology. You are certainly aware of the changes in communication technology over the last several years. They are occurring at lightning speed. 10 years ago, I did not do my email, my calendar, my calculator, (even tuning for my horn) on my mobile phone. Today, there are thousands of apps for almost everything you can dream of. I am not in the tech industry so I certainly do not claim any sense of understanding what the next 10 years will bring. But all indications I have heard suggest that things will be quite a bit different - especially in the world of technology. The big question here is - What does that mean for the broadband world? I have talked with several people (tech people) who have told me that fiber is the way to go. As you noted, fiber is light speed<sup>1</sup>. You can't get much faster than that. But is fiber technology done? If the city (or someone else) lays miles and miles of fiber in the ground today, will technology improve in 10 years where that type of fiber would be obsolete?*

I'm not sure which of two questions you're asking here, but the answer is No in either case.

If you are asking whether in ten years there will be a better kind of optical fiber that would make ours obsolete before the construction debt has been repaid, it is true that technologies improve over time. But there are at least three reasons why the answer to this question is No.

- Once our fiber is in place, the next technological upgrade will replace not the fiber cables, but the laser transceivers that send and receive information. That would happen in five to seven years, and the cost is included in the financial model. If you look at the standard to which our network would initially be built, an upgrade to the next-level standard should increase capacity for a 1 gigabit subscriber to 10 gigabits. That's an enormous number.
- We would lay cables containing many more fibers than required for current needs, because it has become remarkably inexpensive to include extra fibers at construction time. Today, this is the ordinary course of affairs when building out a network. It allows cheap expansion of both the number of users, and the bandwidth provided to each user.
- Our network would not become obsolete simply because improved fiber optic technology is developed. It would only become obsolete if it can't meet customer needs. We would build capacity to greatly exceed any foreseeable need in the next ten to twenty years.

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<sup>1</sup> The speed of light through glass is less than the speed of light or radio waves through the air. The issue here is bandwidth – how much continuous information flow the system can sustain. This is like the difference between how fast water is flowing through a pipe, and how fat the pipe is. Optical fiber is a very fat pipe with very fast flow – yet not as fast as through air or a vacuum.

If you're asking whether fiber will be rendered obsolete by a completely different technology, the alternative would be extremely high frequency, very small cell wireless networks. I've also addressed this for your question #8, but for the moment let me just observed this:

- 5G cell towers will require to be fed directly from 20 gigabits per second fiber optic connections. And there is presently discussion of ... can you guess? ... how much fiber capacity will be needed, because it is likely for technical reasons that many of those fibers will ultimately be connected directly to home and office endpoints.

**In my opinion, the answer to your question #2 is No.** But why not ask a communications engineer?

3. *The financial model you have built and discussed in your review is obviously built on today's information. And I completely agree, it is a sound model. But again, what about potential changes in the future? Some people have compared the so-called broadband utility similar to the city's elec and water/sewer utility. However, in my opinion, this is NOT a good comparison. Electric power hasn't changed much over the last 100 years. And water is the same as when the earth was created. Broadband, however, is part of an ever changing and quickly changing technology that will not last over the decades as an elec or water utility has.*

The nation's electric power grid is far into obsolescence. It runs much too close to its capacity limits. Its major segments are too large and not well isolated, and the system lacks adequate redundancy. The control systems are vulnerable to Internet attacks that could easily destroy generators – maybe many at the same time. Solar power is undermining the pricing model of classic electricity networks, and even inverting the fundamental business model, because solar-assisted customers often produce excess power they'd like to feed back into the network. And distributed power storage seems likely to further transform the business.

Structural impediments make it very difficult for the power industry to respond to these changes. In contrast, telecommunication technology changes are foreseeable, widely discussed, affordable, and based on publicly shared technology and standards. Moreover, new telecom technologies are always designed to operate side-by-side with established ones. The roadmaps are published and debated because customers, service providers and technology manufacturers absolutely require interoperability.

Yes, the broadband industry be more dynamic than power and water, but that risk is offset by the industry's necessary and deliberate strategy of radical visibility about what's coming down the road.

That said, a broadband utility really is *financially* similar to an electric utility. The same economic forces would drive broadband toward a "natural utility" destiny, except that government policies were put in place to prevent it. Those policies were propagated into state laws like SB-152 by the telecom companies, who strongly influenced the text to protect their franchises. The result in cities like Loveland has been to segment the customers among a few providers, and then let investment stagnate where the returns would be relatively low. The logical solution is to create a broadband business model specifically designed for a low Internal Rate of Return.

Every capital-intensive industry works by raising capital, matching the maturity of debt to the useful life of the asset, then building the asset and selling the product. In our case, we can look at the technology

roadmap to estimate the useful lifetime of our network, and whether wireless technology would be a realistic substitute. We can look for ways to shorten the duration of the debt, and so on.

Nobody is proposing that Loveland should build the next Comcast or Verizon Wireless. We're talking about one project, not creating an industry, and we only need confidence that our asset will outlast the construction loans.

There is one difference of circumstance between broadband today and our electric utility. There are existing broadband competitors in place who could possibly compete by predatory pricing. If we offer the lowest possible subscriber price, we might be unable to respond with a lower price. I doubt whether this is a realistic threat, because broadband providers also compete among themselves and must maintain positive returns to support their own debt. But it's possible, so maybe we shouldn't offer the very lowest price that our costs would allow.

**In my opinion, this decision does not ride upon an argument that a broadband utility is "just like" a power or water service.** This project should be evaluated exactly as it is, not by analogy. The decision revolves around whether we can safely afford it, whether the attractiveness of our fiber optic network will outlive the bonds, and more generally whether it complements or impedes other things the City may want to accomplish. A fiber optic network would have a very long useful lifetime compared to the historical 10-year lifecycles of wireless technologies. If wireless advances faster than we anticipated, some wireless provider(s) would need fiber to feed the towers they would built in Loveland. We could sell capacity, or sell the entire network to such a provider; by then, most of the debt will have been paid down anyway.

4. *With that in mind, this leads to the big concern of whether we want the city to enter into and be a part of the ever changing and highly competitive world of communication?*

This question, or anyway the thinking that motivates it, may overstate what's being proposed. Yes, the City would have to create a department with knowledgeable staff to operate and maintain this thing. If City staff are really opposed, that could be an argument against. But if it came to pass, **Loveland would be more like a consumer of high tech than a competitor in the industry. A municipal broadband network would be something new for Loveland, but I think the scope is far more modest than this question suggests.**

5. *You identified 5 risks in your document. I agree completely - they are well stated. The last one (#5) is "capital competition". You correctly state this is a political choice and decision. I also agree with your statement that this should be a municipal enterprise that will eventually be self sustaining. But in the beginning of the utility, you said this will need to be backed by assets and revenues. Later in the paper, you note that this backing would most likely be our electrical utility. Your opinion seems to be this is not much of a risk because the broadband utility has a high likelihood of succeeding so the risk to our electric utility would be low. However, I have heard other opinions to the contrary that suggest that the success rate of a broadband utility would not be as high which would subsequently put our electric utility at a greater risk. Quite frankly, this is a risk that I am very, very skeptical about taking.*

When I give in to emotion, I'm right there with you on this concern. I really feel it.

The argument in favor is that encumbering the electric utility would substantially reduce the project's cost of capital. That would allow a lower service price, which should improve subscriber uptake. I suppose the City's consultants have proposed or conducted a survey to determine subscriber price sensitivity, but I have no information about that.

A lower cost of capital would reduce the single most important project risk. How should this be balanced against all the customers' money saved, the number of residents who would get good service that they didn't previously have, benefits to schools, and everything else? That's hard. Maybe we should call a bunch of smart people together to noodle about this.

It's useful to distinguish between smooth or continuous risks that can be weighted by their probabilities, and risks with a small, uncertain probability but severe consequences. Emotionally this feels like the latter, but on close examination it appears more like the former.

That's because risk to the electric utility is a secondary risk, not a primary one (although politically, it sure looks primary). It's a potential consequence of other risks that can, themselves, be assessed and mitigated; it's not an independent, uncontrollable source of failure. This concern should be judged against a fully conceived and designed project proposal. It's too early to assess.

**I'm uncomfortable, but I believe this risk would be low and I haven't concluded that it's a killer.** The path forward is to proceed with the investigation, looking for every way to avoid or reduce *all* the project risks, because those other risks are what make this one dangerous.

*6. In your model, you talk of the relatively long pay-off time for the bonds that a city could enjoy as opposed to a private investment that would require a shorter pay-off time. This obviously makes sense on its own. However, again as noted above, with the communication tech world changing at such a rapid pace, it seems like carrying the debt for a longer pay-off period puts the investor (the city) at a greater risk for actually getting the anticipated pay back.*

The primary payback would be for the *subscribers*. They would start receiving their payback as soon as they enroll, in the form of lower Internet service prices with vastly better performance and reliability. The City would build and operate custom infrastructure on their behalf. If the project is configured and financed to earn a small, positive Internal Rate of Return, that's good enough. The IRR does not include customers' saving compared to alternatives, it reflects only the explicit cash flows of the business.

Unless something technologically unforeseen happens, the project would have a small but positive running cash balance until the bonds are paid off. Then Loveland would really be in the clover. Meanwhile, subscribers would have accumulated a huge net positive benefit. Let's hope they spend it on college educations, or at least that it gets spent locally instead of flowing out of the community.

Again, there's a balance to be struck here. Longer debt makes somewhat lower subscriber service prices possible, and the total risk will be lower if more people subscribe. If subscriptions exceed expectations, Loveland can repay the debt down faster. Most muni bonds are issued with early-call provisions.

**That said, any borrowing should be as long as necessary but as short as possible. Don't stretch it out just because we can.** My own modeling seemed to show that twelve years post-construction is about right, although that's a parameter which could be adjusted. With real numbers from your consultants, that number might be different.

This might be an opportunity to proceed by making a new path. I've asked someone to inquire in principle about financing such a project directly through a bank (or a few banks), which could allow a simpler, faster paydown and eliminate the City's reinvestment rate risk (interest earned on cash held for future bondholder repayment). There is a lot of flexibility in modern finance. If the interest in such an arrangement would still be legally tax advantaged, this might work. Or it might be a wild hare, but it's worth asking. Banks are not exactly running out of money to lend these days.

Why not be patient on this question? Now isn't a great moment to issue bonds anyway, because those guys in Washington are talking about perhaps eliminating the tax advantages of municipal debt. That would create an enormous one-time profit for grandfathered holders of existing muni bonds, and immediately kill a lot of infrastructure projects that those same politicians say they want to stimulate. I don't think they'll do it, but wild ideas are in the air and bond buyers like to know what they're getting.

7. *You (as well as many others) have compared the Longmont experience to what Loveland's could be. However, I question whether that is completely true or not. Longmont was the so-called "pioneer" into this venture and suffered some set backs along the way. Great for us and others so we can avoid some of the learning curve pitfalls they went through. However, something needs to be considered for them being the first in the market in their area and therefore had a distinct advantage compared with other private carriers. Loveland however (if we jump into that world) will be 5-7 years behind Longmont. Again, considering tech changes as well as market changes in that time, I believe it would be foolish for us to try to emulate the Longmont model too closely. We may end up in a competition or tech trap that we would be unprepared for. For example, the uptake rate experienced by Longmont has allegedly been higher than anticipated. Good for them! But, will Loveland have the same results? Given the changes in the market, I would highly doubt it. We would have to model to a more current and perhaps lower rate to be more certain of success.*

Even if we'd done our project at the same time as Longmont, we might have had a different uptake rate. Here are four factors that could make Loveland's uptake rate lower than Longmont's:

- Our demographics and personal income distributions might be materially different. (But Richard Toftness looked into this and thinks not.)
- The performance of cable-based Internet service has improved, where it's available, with somewhat more improvement to come. Physics dictates that coax cable bandwidth will always remain far from fiber optic bandwidth. But today's cable Internet service is better than what Longmont had three years ago.
- If we bury more of our fiber than Longmont, or otherwise incur greater construction expense per capita, our higher cost would require us to set a higher end-user price.
- Loveland might not market as effectively as Longmont did, or might fail to take other actions that could increase uptake.

Longmont understood the critical importance of uptake rate, and acted effectively to influence it. They built woo and marketed their creation boldly. They took some tightly judged price risk that really paid off in subscriber acceptance. Other factors that I believe contributed to their success are that they understood their costs rather exactly, raised capital incrementally, moved fast, and offered subscription incentives that no commercial subscriber could promise.

In other words, the Longmont team got committed and acted accordingly.

Loveland absolutely must assess the expected uptake rate over some financially sound range of service prices. The City's consultants should survey to estimate the price elasticity of our uptake rate.

But insisting on perfect confidence, or over-compensating by radically depressing the assumed uptake rate, could kill the project unnecessarily. The correct path forward is to set reasonable, justifiable uptake goals and act to achieve them.

Here are factors that would tend to support a high uptake rate in Loveland:

- The need for good Internet service has only increased since Longmont started their build. It will continue to increase as video entertainment migrates to Internet delivery and 4K ultra-high resolution pictures. This increases my confidence about uptake rate.
- My own modeling showed that Loveland's nominal 2% population growth rate compounds into a surprisingly large positive impact. Reflecting on this, I concluded that fiber service would be a no-brainer for almost all new homes and offices, though I didn't build that into the model.
- Another positive factor is increasing use of "cloud" based data services. This gradual but accelerating shift in software architecture requires faster upload speeds than in the past (which also presses on a technological limitation of copper cable based services). And it's not a choice; app builders use cloud services because they are fast, inexpensive, ubiquitous, and provide access to large datasets that can't be stored on individual devices.
- Our cost to build this network should also be a floor on the cost of any competitor who would provide the same services to the same customers.
- Our costs should be lower than competitors because we can use the existing PRPA loops, we have some rights-of-way advantages, and because of the other advantages discussed in my memorandum. Therefore, our service price should remain below competitors. Customers won't have a lot of alternatives.
- Acting forcefully to drive uptake is one of the two key points of leverage that can greatly reduce risk and make this project a great success. If Loveland proceeds, that forceful action ideally should begin with a committed and supportive Council and staff.

**We might not see the 50%+ uptake rate that Longmont is experiencing, or not immediately. It might depend upon the order in which areas of Loveland are built out. But 40% uptake rate seems like a reasonable modeling assumption, and some factors supporting higher uptake will strengthen over time. I would examine the survey data with sober eyes.**

*8. There has been a lot of discussion about the future of wireless. You discuss that briefly in your notes. Your suggestion is that technology for this to be a viable issue at all is at least 5 or more years out. But I have read and heard other opinions suggesting that wireless will be a huge force in the*

*communication world in the near future much more than perhaps some anticipate. With our societies expanding mobility, the need for constant connection wherever and whenever you are appears to be a big driving force for the future. In fact, some are suggesting that having a fiber line to your home with a Wi-Fi modem will perhaps not even be necessary. Now, I certainly understand that this will most likely not be a very viable option for businesses that rely heavily on high volume and high speed at a stationary location computer. But the market, as I understand it, is looking very strongly at the individual usage and that is where the high mobility issues come up. Again, this causes me concern for risk to the city in the future. If this is true, the city's investment in miles of fiber in the ground and to each home could potentially become somewhat obsolete in the not too distant future.*

**This concern seems far too optimistic about timeframe, engineering challenges, and technical details. 5G cellular wireless will not displace installed or new fiber optic networks in the timeframe that concerns us, if ever.**

I recently ran across a discussion about how much fiber capacity should be installed to serve future 5G towers, *recognizing that some of those fibers will be connected directly to homes and offices*. Fiber and wireless technologies will continue to develop side-by-side for a long, long time. Meanwhile, fiber network performance will grow faster than wireless, sooner, and will beat any feasible performance of future radio systems by factors of 10 to 100.

Fiber and radio serve different “use cases”. While you might think that home Wi-Fi for mobile devices could be completely replaced by a fast, general purpose mobile-radio network, it will be extremely difficult for super-high-frequency, exterior mobile networks to fully cover the interiors of many homes, and impossible within office structures. Manufacturers will continue to include both Wi-Fi and cellular radio in mobile devices, and transparently switch between the networks in real time.

I already do exactly this at home, where I have a “wireless mesh” of routers connected to my Internet service. The routers transparently relay signals among themselves and track mobile devices in the house as we wander around making Wi-Fi phone calls, browsing the web, watching movies, and playing games with friends in Japan. It’s secure and works fantastically well. With this simple setup, there is no need and there’d be no benefit from a complex 5G system that requires an 18-foot tower to serve every 25 homes – assuming foliage from tall trees didn’t block the signal. But it does – leaves are opaque at such extremely high radio frequencies. Whereas if I get fiber-optic service tomorrow, every square foot of my home will immediately have that super performance, which will continue to outrun wireless, without changing a thing inside.

5G radio towers providing bandwidth to compete with fiber would need to be ubiquitous, maybe 1500 or more to cover Loveland, and will require fiber-optic feed connections. With our own network in place, Loveland would be ready to serve those towers if this new wireless tech arrives sooner and more powerfully than expected. We could lease capacity or sell our network to a 5G provider.

I could provide deeper technical details, but this document is already very long and wide-ranging. If you’re still concerned, we can also refer this question to some communications engineers, or you can ask Loveland’s broadband consultants.

9. *I do agree and like your suggestion (if we pursue this further) of some type of CO-OP between municipalities in the area (similar perhaps to PRPA). It just seems intuitively obvious that a group approach to something this far reaching would be far better than each municipality struggling through on it's own. As you know, this concept was being discussed when the Axia option was being looked at.*

**I believe very strongly that this the second powerful leverage point that we should use to reduce project risks.** After the project is built out, ongoing operations and support will be the primary expenses. That's mostly staffing costs. Every dollar we can save is a dollar to pay down our construction debt faster, or leave in citizens' pockets.

Fiber-optic networks are very stable and reliable. A single operation and marketing team should be able to support three or four cities, instead of having redundant teams for each city. If Fort Collins, Loveland, Longmont and maybe Estes Park shared that team – perhaps also the network front ends – we could all save money and shorten our debt durations. Maybe we could design the broader network for increased redundancy and reliability.

But that's not all. Cooperating to build a Northern Colorado regional broadband network would have enormous marketing benefits. Wider branding would provide a powerful marketing vehicle to increase credibility and attract more subscribers.

And it would create a credible identity not just for the network, but for the NoCo region. Too many outwardly directed branding efforts miss the point: a brand should be the outward symbol of a genuine, internal identity. Loveland's broader economic development would benefit from being able to show businesses and investors how we fit into the broader Northern Colorado *economic* network.

It's impossible to be certain about some of your questions, Dave. These are judgments about taking some risk to create the future we want. I hope this letter helps you and the rest of Council feel better informed. Thanks for raising these questions.

With kind regards,

Roger Ison

