Appendix E – Description of Cost Estimating Assumptions

EXCERPT FROM TECH MEMO 2

AUGUST 29th, 2016

COST ESTIMATING ASSUMPTIONS

[WITH CHANGES AND ADDITIONS – SUBSEQUENT TO TECH MEMO 2]

For purposes of capital cost estimating, it has been assumed that new or upgraded sanitary sewers or storm drains, to be located within municipal road rights of way, and portions of service connections within the municipal road rights of way, would be paid for by the 'project'.

All new private service connections required within individual private properties are to be funded by the benefitting land owners.

The District has decided that Uplands residents will connect per the conditions decided by Council.

We have compiled the capital **and O&M** cost estimates as aggregate values for each of the options, inclusive of costs to private property owners and to the municipality. We have sought to demonstrate the overall expected project lifecycle costs for each option.

In addition, the following assumptions or clarifications pertain to the cost estimates as complied thus far.

1. Lining or rehab of the existing system is NOT included in the project. Some localized, initial phase, existing system upgrading is included per options 2 & 4 as noted in the estimate breakouts.

2. We will assume the District's stated annual capital budget allocation will be accumulated and expended every 5 years as construction projects, in 2015 dollars - indexed to inflation. Initially, however, we have combined, for simplicity of initial options - net present value - comparison, such that capital works are expected to be completed for each option as a single contract unit in year one, for each option.

3.

a. Annual O&M costs [including periodic equipment replacement] have been added as estimated percentages of initial capital costs, for both private and public initial capital works. These percentages have been varied to reflect estimates of the relative degree of anticipated on-going operational system costs.

b. Commonly, for planning study purposes, operation and maintenance for gravity sewer systems is expected to cost in the order of one to two percent of initial capital construction value. This can vary considerably, based on parameters such as the age of the system, the complexity of system components, the degree of labour intensive maintenance required, power consumption expectations for pumping systems, etc.

For comparative purposes, we arrived at the following O&M percentages:

- 0.5% of capital cost for gravity pipe network
- 0.25% of capital cost for municipally owned pressure sewers
- 2.5% of capital costs for municipally owned pumping equipment
- 3.0% of capital costs for privately owned pumping equipment

These percentages reflect the expected 'economies of scale' afforded to the municipality, particularly as related to on-going pumping equipment costs. Longer term net present value of the options are sensitive to, and are affected to a material degree (over a 50 year design life) by the cost of on-going operation and maintenance.

c. Private property capital and O&M costs/dwelling unit will be broken out to the extent possible, noting dwellings with existing twin services and existing pumps, relative lengths of proposed services, etc. However, these will be aggregated for purposes of overall options assessment and comparison.

d. Operation and maintenance costs for on-site private service connection pipes are considered to be very low and have not been included in this analysis.

e. Operation and maintenance costs related to the maintenance and upgrading of the existing combined system – in order to render it useful to continue in service for another 50 years, is explicitly not included herein.

f. Annual operation and maintenance costs are cited based on percentages of capital costs, net of contingency allowances.

4. We have applied a 30% capital cost contingency, to account for preliminary design phases uncertainties, such as location of other utilities, etc.

5. Soft costs, such as engineering, project management fees, permitting fees/costs, District administration costs, and an allowance carried in anticipation of archeological issues assistance, are included, in aggregate, as a further 20% of capital construction costs estimated.

6. Net present value calculations will assume the discount [interest] rate and inflation rate will offset, with inflation projected to outstrip interest accumulated over the project duration.

7. This is a relative cost comparison exercise. Absolute costs are estimated at preliminary design phase to at best +/- 30%, but relative costing comparison remains valid, assuming consistent application of assumptions.

8. Manholes are included in the per lineal metre pipe prices, at a between $50 and $100 per lineal metre, depending upon pipe diameter and depth.

9. Road restoration is estimated in a range of $150 to $250 per l.m. of trench.

10. We note these are relatively congested existing road r/w with many existing utilities, with moderate traffic expected. Alternate routing/detours for all but local traffic will need to be provided for.

11. Uncertainties as to existence of concrete pavement structure to be excavated through, street lighting and shallow utility conflict potential, street tree and landscaping remediation within public lands, all are to be accounted for in the 30% contingency amount at this stage

12. Probability of encountering bedrock was initially [for tech memo 2 cost estimates] per Ryzuk report dated Sept, 2015. This work was augmented by a more detailed investigation undertaken BY WSP – Victoria – per a report delivered in August, 2016. Following the methodology as cited in the WSP report, we accounted for the probability of trench rock as follows:

    - Rock costing was calculated on the basis of an average volume of trench rock per the depth ranges having been used in the original cost estimates, being:

        - 0 to 2 metres depth
        - 2 to 3 metres depth
        - 3 to 5 metres depth

    - We then based the estimated volumes of rock per unit length of trench based on the 'green, orange and red' designations as cited per WSP:

        - Green – 10% probability of rock at 0 to 4 metres depth and 25% probability of rock at greater than 4 metres depth.
        - Orange – 60% chance of encountering rock at 0 to 4 metres and 100% chance greater than 4 metres depth.
        - Red – 80% chance of rock at 0 to 3.5 metres, with 100% probability of rock over 3.5 metres deep.

    - We then re-evaluated all preliminary design plan/profiles having been prepared for tech memo 2, for all the options, in order to assess the proportion of the total trench volumes as rock, given variations in design pipe inverts throughout.

    - This was accomplished by assessing each sub-run, essentially street by street, assessing which pipes as designed per option, would be situated in a green, orange or red area. Proportions of total lengths at differing depth ranges were attributed to each of the rock probability 'colour' zones.

    - Some adjustments of profiles were made at this time, noting opportunities to deepen pipes in green areas, and likelihood of need to make other pipes slightly more shallow, [if not resulting in more private pumps], in areas denoted as 'red'. Variations for trench width were also accounted for, given the differing proposed pipe diameters, and resulting expected trench dimensions, resulting in expected typical volumes of trench excavation for each combination of pipe diameter and pipe installation depth range.

- We then summed these values to arrive at expected total volumes of rock to be encountered, expressed as cubic metres of rock per original breakout of pipes by diameter and depth range.

- Costs per cubic metre of rock were estimated on the basis of past experience in similar trench conditions. Noting the need for small diameter drill holes in a relatively tight pattern, with relatively small blasts so as to protect existing adjacent utilities, this is expected to be a relatively slow and costly process.

- We arrived at unit rates per cubic metre of rock varying from roughly $80/cu.m to $200/cu.m., depending on the depth and the total volume to be blasted [i.e.: relative difficulty and economy of scale]. These numbers were corroborated by discussions with Western Grater, a local CRD area specialty drilling and blasting contractor. In the most recently updated August, 2016 cost estimates, we have carried $100, $150 and $200, for shallow, medium depth and deeper trench rock respectively. Eg: this translates to roughly $200 to $500 per lineal metre for rock blasting and removal alone, at 3 metres rock depth. Deep sewers in rock will be very costly to install.

- Rock bulking factor, i.e.: rock excavated will have a larger volume that in-situ, pre-blast, has not yet been accounted for in terms of spoil volume.

13. In part to reflect the loss of pipe laying production expected due to rock blasting efforts, and in part reflecting the expectation that some trench excavation material will not be suitable as backfill, - per WSP report - we have increased the unit rates per lineal metre of pipe, for all options, by between $100 and $150 per lineal metre. This, as compared to rates cited subsequent to tech memo 2.

14. Pre-design phase private service connection cost estimates are based on professional judgement; not detailed, site specific assessments.

    Service connection assumptions: short = 20 m or less, long are greater than 20 m. We added to this, further breaking down the costs of service laterals for the August, 2016 cost estimates, as requested.

    - Deep vs shallow services, with 3 metres average depth being the decided threshold between the two.

    - Rather than attempting to determine which individual services would be predicted to be situated at least partially within bedrock, perhaps differing in similar proportion to the abutting green, orange and red main line rock probabilities, we decided on the following simplifying assumption - as an allowance for rock, added to the average cost per unit service connections:

        - Add $1,000 for shallow services
        - Add between $3,000 and $5,000 for deeper services, short vs long laying lengths.

- Service connections are now cited as follows [in addition to pumped systems, as applicable]:

  Within road rights of way – lower average restoration costs
  Short and shallow - $7,000
  Short and deep - $10,000
  Long and shallow - $12,000
  Long and deep - $20,000

  Within private properties – higher average restoration costs
  Short and shallow - $9,000
  Short and deep - $12,000
  Long and shallow - $15,000
  Long and deep - $25,000

- Where onsite short/shallow service, for example, is estimated to be broken down as:
  - Labour and equipment $5,000 – 2 full working days.
  - Materials $1,000
  - Restoration $2,000
  - Rock allowance $1,000
  - Total $9,000.

As a check on these assumptions, a long, deep sewer gravity service, on-site, at 40 metres length is estimated at $625 per lineal metre, including an allowance for rock. This is, at first thought, a very high cost per metre for a small diameter service connection, but we believe reflective of the difficulty, on average that many dwelling owners will face when attempting to route a deep gravity service across exiting developed properties.

15. Costs estimated for private, on-site pumping stations include the following allowances: pumping equipment/tankage, controls equipment, plumbing connection, electrical connections/new sub-panels, site excavation and restoration and a small, portable power generator.

[Costs for private service lines, connecting from the on-site pump to the road right of way, is not included in the $9,000 private pumping system aggregate cost. Costs for service connection pipes are broken out separately per above].

16. Costs for municipal pumping stations allow for a portable, trailer mounted back-up power generator, rather than permanent on-site gen-set facilities at each station.

17. 391 total services to be provided. 80 existing sanitary services are expected to be reused for the #1 and #2 options, for the onsite portion of works. For options 4, 5 and 6, we have assumed ½ of these 80 dwellings will need a new pumped service to be re-laid, due to proposed shallow gravity mains in the roadway and/or are found to be on an unusable plan alignment. I.e.: the existing service on private property will be too deep.

18. 17 existing sanitary pumps and 13 existing storm pumps have been accounted for. The number of existing pumped connections could be reduced, for options 1, 2, 3, & 6, depending on final design grades. Assumed here that all will be reused.

19. Sites with two existing onsite services will cost less to reconnect for options 3, 4, 5, & 6, due to reduction in separation cost at the existing buildings.

20. Service connections in the roadway are expected to require 1 production day for short services and 2 production days for longer services. Complications are expected to potentially include attending to existing:

    - Buried lighting wires
    - Buried hydro/tel/cable
    - Buried gas mains
    - Former concrete pavement structure

21. The cost estimate for service connection portions within road rights of way is representative of an average cost for services constructed concurrent with installation of the mains and services constructed at a later date by others.

22. Archeological risk has not been differentiated between areas of probable higher and lower risk. It is assumed that all six options will impose similar risks, given the proposed depths of the infrastructure to be installed.

23. Capital costs cited include expected contractor profit and overhead.

24. Capital Costs to the municipality include the portions of proposed individual service connections located within lands under the municipality's ownership or control.

25. No seismic impact considerations have been accounted for in the cost estimates, thus far. Similarly, the impact of sea level rise on the gravity network, and on the CRD's pumping stations has not been factored into the long term costing for this project scope.

26. For option 4, the existing storm main along Lansdown is not sufficiently deep to pick up adjoining services, now connected to the deeper combined sewer. Therefore, these dwellings would need to be pumped.

27. Production rates are estimated at 40 m/day for shallow sewers and 20 m/day for deep sewers. This will be reduced to a degree, by the presence of rock and, if so, on the pipe installation contractor's ability to undertake other works whilst rock removal operation is undertaken.

See tabular example price per lineal metre breakdown for 300mm diameter pipe at 3 to 5 metres depth. Inherent in these costs per lineal metre is the assumption that some significant proportion [roughly 50%] of existing trench excavation material can and will be utilized as trench backfill, [rather than disposing offsite and 100% import trench backfill].

Trenches in non-rock excavation areas are assumed to require trench cages and therefore will have a base width at pipe invert of the applicable pipe diameter plus 1,400mm, with some slight batter to the road surface resulting.

28. On-site service connection costs and pumping equipment installation costs will vary considerably, depending on site specific circumstances. It may be that private property owners eventually elect to contract for design and installation of a pumped system complete with a shallow pressure sewer discharge pipe, instead of a deep gravity connection. In some cases, the routing for a deep gravity connection over private properties, particular from dwellings on the low side of a given roadway, will be very difficult to install and will potentially be very costly, given impacts to existing surface improvements/trees.