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memo

TO:	Shawn Kohtz, PE
FROM:	Brad Hammerquist, PE
DATE:	2/2/2024
JOB NO.:	0417.088
RE:	Life Cycle Costs – Compact Development Infrastructure
CC:	James Nickelson, PE

☐ **Urgent**	☐ **For Review**	☐ **Please Comment**	☐ **Please Reply**	☒ **For Your Use**

Introduction

The high cost and short supply of housing in the City of Bozeman is a dominant topic within the community. To address this issue, the City is exploring ways to reduce upfront costs to land and infrastructure construction that enable a higher density of housing and reduce need for additional impact to the environment. One method of addressing this has been "compact developments". To assist the City in its project to revise Engineering Design Standards, this analysis has evaluated several infrastructure design elements associated with compact land uses against its current design standards from the perspective of life cycle cost. Life cycle cost was chosen as the metric of importance due to its connection to providing affordable housing. It should be noted that compact land use and the compact development infrastructure evaluated within this analysis can be mutually exclusive. Compact land uses do not inherently require compact infrastructure. While compact infrastructure can be successfully implemented and has been demonstrated to varying degrees in other cities across the country, this analysis evaluates the additional operating costs associated with maintaining said infrastructure in the type of winter climate for which the City exists. Compact infrastructure may reduce initial capital costs; however, the reduced upfront infrastructure cost is often offset by long-term increased cost of Operation and Maintenance (O&M) of that infrastructure.

There are many types of high-density developments that do not deviate from the City's existing engineering standards, such as certain small-lot and shared-lot developments, apartments, townhomes, and condominium developments. In these cases, the City's existing engineering standards can be met.

Non-standard infrastructure strategies that have been implemented under the "compact development" concept include:

- Reduced right of way
- Reduced road width
- Reduction or elimination of curb and gutter, boulevard, and sidewalk requirements
- Reduction in minimum off-street parking requirements
- Non-standard water and sewer service locations

While these strategies may reduce the initial cost of public infrastructure construction, they often increase ongoing operational and maintenance costs and create long-term challenges for the City and residents in these developments. These costs are typically passed on to property owners and renters through HOA fees and rents.

This paper describes and compares infrastructure life cycle cost differences between infrastructure development types that meet existing City engineering standards and those types of infrastructure that do not. The purpose is to determine if the reduced initial cost of construction associated with not meeting existing engineering standards also reduce the overall life-cycle cost of the infrastructure upon incorporating ongoing operations and maintenance costs. This paper does not attempt to refute compact land uses nor their benefit to environmental sustainability. The City has demonstrated through numerous and recent developments that compact land uses can be served by its existing design standards and therefor is not a matter that is required for study under this project to revise Engineering Design Standards.

Development comparisons of projects that meet existing City engineering standards to those that do not meet existing City engineering standards are impacted by development configuration, site constraints, housing product type, and densities which vary widely throughout the City of Bozeman. Four existing developments have been chosen for evaluation. It is understood that each type of development has various qualitative pros and cons and that a diversity of housing options is important to the community.

Maintenance and Operational Challenges

The following challenges are associated with infrastructure that does not meet existing City engineering standards. This list has been compiled from public comment received by the City as well as the experience of the City's operating divisions. These challenges result in higher life cycle costs and reduced level-of-service for residents.

- The City does not maintain (remove snow, seal cracks, resurface) streets that do not meet City standards due to increased time and equipment requirements that cannot be met under existing levels of taxation. Therefore, residents in subdivisions that have substandard road sections have an additional maintenance cost burden when compared to residents that receive this service from the City. City staff have reported numerous requests from residents to take over these services from their HOA due to perceived poor service and high costs of private contractors.

- Elimination of boulevards, defined as the strip of land 4' or greater between curb and sidewalk, reduces available snow storage for winter plowing operations. In many cases, snow may even need to be hauled by truck to a different part of a development or off-site. Loading and hauling snow in dump trucks is significantly more costly than pushing snow into the boulevard.

- Reduced off-street parking not meeting demand results in more vehicles parked on streets. The increase in on-street parking increases conflicts with street sweeping, snow removal, and solid waste collection. These conflicts slow the pace of service and therefore increase cost of services provided by the City.

- Compact developments with houses that do not have direct access to water and sewer mains within streets can result in long water and sewer services in locations that are difficult to access. Longer water and sanitary sewer mains are expected to have higher failure rates per residence due to the longer length of piping.

- Water and sanitary sewer services are the responsibility of the property owner downstream of the curb stop or outside of the right of way. Installation of services below landscaped areas, between houses, near foundations and hardscaped areas makes them more costly to repair and replace when compared to standard locations. Accessing and excavating in these areas can be very disruptive to residents.

Life Cycle Costs and Present Worth

The life cycle cost of an infrastructure facility includes the initial cost in addition to other costs incurred during the life of the facility, such as operations, renewal, and maintenance costs. Since many of these costs occur in the future, the Present Worth (PW) method is used to transform these future costs to present amounts. This method accounts for the time value of money and allows alternatives with different future cash flow patterns to be compared. The alternative with the lowest present worth is the alternative with the lowest overall cost of ownership from an economic perspective.

Life cycle cost items included in this analysis are summarized below.

Street Sections

Initial Construction Costs

- Pavement Section
- Curb and Gutter
- Sidewalk

O&M Costs

- Snow removal (annual)
- Crack Seal (periodic, 3 years)
- Chip Seal (renewal, 10 years)

Water and Sewer Services

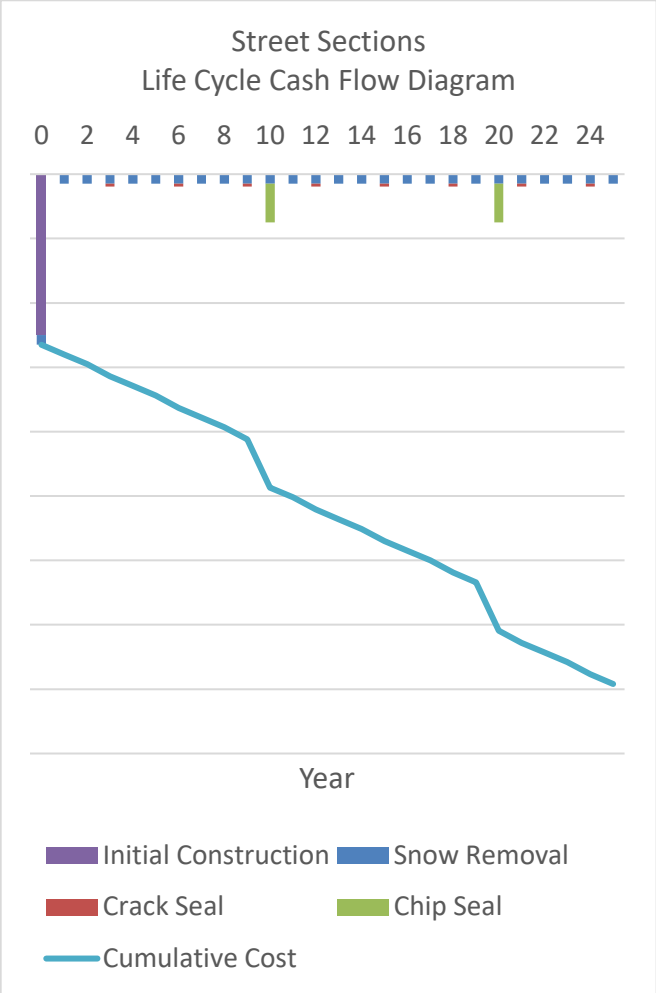
Initial Construction Costs

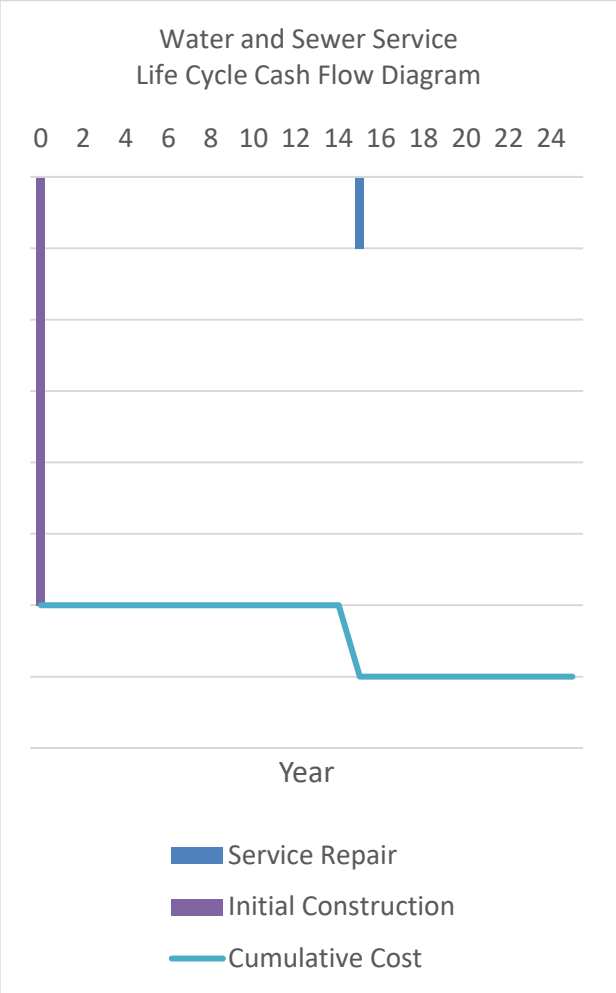
- Water Service
- Sewer Service

O&M Costs

- Water and Sewer Service repair (assumes 1 repair per 2,000 feet of service pipe per 25 years)

Life cycle cost items are depicted as expenses in cash flow diagrams below.





Development Summaries

Four existing residential developments were evaluated with respect to the life cycle cost items described above. Characteristics such as density, home price, HOA fees, and amenities are also summarized for context.

The evaluation includes two compact development types that do not meet existing City engineering standards, a townhome development that meets existing City engineering standards, and a condominium/apartment type development that also meets existing City engineering standards. All of the developments have relatively high densities compared to existing city subdivisions.

C1 – Bridger View Subdivision
Type: Townhomes and single-family residential homes in pocket neighborhood
Zoning: R-3
Number of Units: 57
Gross Density: 7.1 units/acre

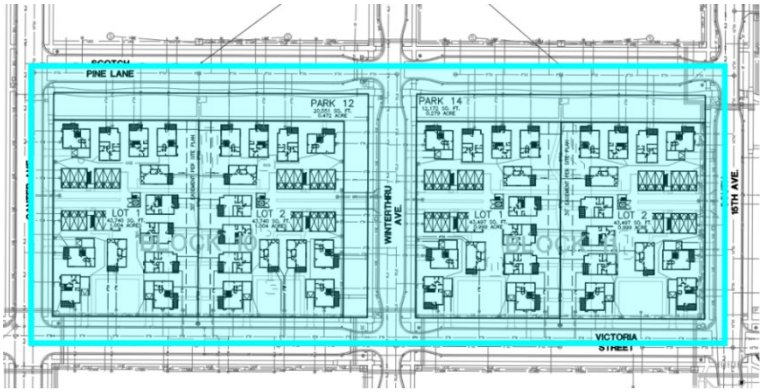
Right-of-way and street widths do not meet City Standards.

Real Estate Information*
Monthly HOA fees: $200 - $361
Amenities included: Clubhouse, Playground, Park, Sidewalks, Trail(s)
Services included: Maintenance Structure, Road Maintenance, Snow Removal, Trash

$524,000 for 1,481 sf, 1 bed, 1 bath townhome ($354/sf)
$759,900 for 2,152 sf, 3 bed, 2 bath townhome ($353/sf)

Infrastructure Initial Cost: $26,300 per unit
Infrastructure PW: $45,500 per unit

C2 – Blackwood Groves Subdivision
Type: Leased Single Family Residences
Zoning: REMU
Number of Units: 49
Gross Density: 7.2 units/acre



External Right-of-way and street widths meet City Standards. Water and sewer services do not meet standards.

Real Estate Information*
Monthly HOA fees: Assumed to be included in lease
Amenities included: Business Center, Clubhouse, Fitness Center, Lounge
Services included: Garbage, Internet, TV

$2,100/month for 690 sf, 1 bed, 1 bath residence ($376/sf with $260,000 mortgage)
$3,300/month for 1,226 sf, 3 bed, 2 bath residence ($367/sf with $450,000 mortgage)

Infrastructure Initial Cost: $27,400 per unit
Infrastructure PW: $44,800 per unit

**Real Estate Information gathered from internet listings and sell price estimates 12/2023*

S1 – Valley Meadow Subdivision
Type: Townhomes
Zoning: R-3
Number of Units: 61
Gross Density: 7.0 units/acre

Right-of-way and street widths meet City Standards.

*Real Estate Information
Monthly HOA fees: $65
Amenities included: Playground, Park, Sidewalks
Services included: Maintenance grounds, Snow Removal

$575,000 for 1,588 sf, 2 bed, 3 bath townhome ($362/sf)
$625,900 for 1,987 sf, 4 bed, 3 bath townhome ($315/sf)

Infrastructure Initial Cost: $20,300 per unit
Infrastructure PW: $31,000 per unit

S2 – Meadow Creek Subdivision
Type: Condominiums
Zoning: R-3
Number of Units: 56
Gross Density: 10.0 units/acre

Right-of-way and street widths meet City Standards.

*Real Estate Information
Monthly HOA fees: $165 - $250
Amenities included: Playground, Park, Sidewalks
Services included: Maintenance Grounds, Maintenance Structure, Road Maintenance, Sewer, Snow Removal, Water

$594,900 for 1,614 sf, 2 bed, 3 bath condo ($369/sf)
$705,100 for 1,958 sf, 3 bed, 3 bath condo ($360/sf)

Infrastructure Initial Cost: $28,800 per unit
Infrastructure PW: $38,000 per unit

**Real Estate Information gathered from internet listings and sell price estimates 12/2023*

Key cost items for each development are summarize below.

Cost Summary					
Development	Density (units/acre)	Initial Infrastructure Cost Per Home	Life Cycle Cost Per Home (PW)	Home Price Per Square Foot	Initial Infrastructure Cost as % of Home
C1-Bridger View	7.1	$26,300	$45,500	$354	5%
C2-Blackwood Groves	7.2	$27,400	$44,800	$367	6%
S1-Valley Meadow	7.0	$20,300	$31,000	$362	4%
S2-Meadow Creek	10.0	$28,800	$38,000	$369	5%

Initial Infrastructure Costs

For the developments that were evaluated, relaxing existing City standards does not significantly reduce initial infrastructure costs per home. Initial cost of infrastructure appears to be influenced more by the configuration of the particular property. For instance, development S1 achieves the same density of housing as the compact development types, while also meeting existing City engineering standards and provides lower initial and life cycle costs to the homeowner. The configuration of this development allows for an efficient layout of streets, water, and sewer infrastructure.

Life Cycle Costs

The compact development types have higher overall life cycle costs. The cost increases are attributable to higher street maintenance costs in the case of development C1, and higher water/sewer costs in the case of development C2.

Parking

City of Bozeman Unified Development Code, Section 38.540.050, specifies the minimum number of off-street parking spaces required for residential uses. The purpose is to assure that parking availability is roughly proportional to parking demand. Parking requirements in the UDC are complex, however, two off-street parking spaces are generally required for each residential unit with more than one bedroom. Development C1 provides approximately half of the off-street parking needed to meet the demand specified in the UDC. The internal private streets are not sufficiently wide to allow for legal on-street parking adjacent to the homes. Excess parking demand has been observed to induce illegal parking and otherwise will be pushed to the external city standard streets that allow street parking, resulting in increased conflicts with City street maintenance activities and conflicts with accessible pedestrian facilities. Reduced parking requirements have not anecdotally induced a reduction in vehicle ownership or usage as evidenced by the presence of illegal street parking where they exist. Absent of policies that equate vehicle ownership to capacity of parking provided, it should be expected that current rates of vehicle ownership will continue along with the observed impacts to the right of way.

Housing Costs

The cost of housing is most directly related to the size of the home and appears to be primarily market driven. The home cost per square foot is relatively similar regardless of product type and whether or not the development meets existing engineering standards.

Conclusions

Developments that have implemented infrastructure design not meeting existing City engineering standards appear to have higher life cycle costs for both the people in the development and the City. The winter climate experienced in Bozeman demands maintenance practices that require spatial capacity in the right of way not provided by compact infrastructure. Further, the revealed preference of residents in these developments indicates that vehicle ownership and usage has not adjusted elastically with reduced space provided for vehicles. The combination of these observations has led to a conclusion that compact infrastructure practices may increase cost of housing relative to existing City engineering standards. This conclusion should not be interpreted as opposition to housing density and compact land uses, as the City has demonstrated both methods of reducing cost of housing and impact to the environment can be met with existing City engineering standards. However, the City should proceed with caution when contemplating inclusion of compact infrastructure within their revision to engineering design standards due to its potential to increase cost to residents.