Smart Growth & Conventional Suburban Development: Which Costs More?
An infrastructure case study completed for the EPA

by Jonathan Ford, PE
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INTRODUCTION

Since World War II and especially in the last 25 years, Conventional Suburban Development (CSD) was the path of least resistance for the majority of builders. Zoning codes favored CSD, the market was understood, the risks were clear, and the planning, design, and permitting process had been repeated time and time again. However, the development climate has now changed. Developers and builders are looking for ways to cut costs. Municipalities face a steadily growing burden of infrastructure maintenance costs. Energy efficiency is a high priority as the supply of oil and other natural resources are dwindling. Countering the effects of climate change has become a priority worldwide. At the same time, demand for urban, walkable communities is steadily increasing, and supply has not kept up: market studies show a demand gap of one-third.1

Given these realities, there has been increasing interest in Traditional Neighborhood Development (TND) as an alternative to CSD. To further TND’s position as a compelling alternative, developers need to become more comfortable with the methodology and costs associated with building compact communities. A crucial component of this process involves quantifying the cost of TND infrastructure as it compares to the known costs of conventional development practices.


When comparing CSD scenarios to alternative TND designs, the study found that infrastructure costs for the TND scenarios were consistently less than CSD. Reductions in infrastructure costs due to TND development patterns ranged from 32 to 47%, with the extent of TND cost savings based principally on density.

It is important to note that these infrastructure cost studies analyzed one piece of the development bottom line: the cost of infrastructure materials and construction. Costs for design and engineering, vertical construction, price premiums, market demands, and many other local-area market factors influence decisions to design and build using certain design principles.
I: CASE STUDY BACKGROUND

Morris Beacon Design completed two infrastructure case study analyses for the EPA’s Business Case for Smart Growth Publication. Input from a committee of TND and CSD developers and builders was used to establish benchmarks and guide methodology and design assumptions to ensure the case study development scenarios modeled actual development practices as closely as possible.

Case Study 1: Belle Hall

The “Belle Hall” study compared five TND and CSD development alternatives for a 750-acre site in Mount Pleasant, South Carolina. The total development (residential units and commercial/industrial development) for each case study scenario was held constant in order to facilitate accurate comparisons of infrastructure cost. Scenarios A, B, and C were designed with 800 residential units, and Scenarios D and E were designed with 1,410 residential units.

Although the case study comparison was completed for all five Belle Hall scenarios, the builder and developer peer review team determined that Smaller-Lot CSD C and Smaller-Lot CSD Buildout E are not market feasible. It was felt that the lot sizes are too small for typical CSD buyers and that developers would not seek zoning changes to build CSD using smaller lots when the Original CSD B scenario buildout would be by right.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Residential Units</th>
<th>Single-Family Lot Size (sf)</th>
<th>Developed Area (ac)</th>
<th>Residential Density* (du/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH TND A</td>
<td>800</td>
<td>5,000</td>
<td>253</td>
<td>4.6</td>
</tr>
<tr>
<td>BH CSD B</td>
<td>800</td>
<td>20,000</td>
<td>601</td>
<td>2.1</td>
</tr>
<tr>
<td>BH CSD C</td>
<td>800</td>
<td>5,500</td>
<td>384</td>
<td>4.6</td>
</tr>
<tr>
<td>BH TND D</td>
<td>1,410</td>
<td>varies</td>
<td>253</td>
<td>8.0</td>
</tr>
<tr>
<td>BH CSD E</td>
<td>1,410</td>
<td>5,500</td>
<td>525</td>
<td>4.5</td>
</tr>
<tr>
<td>DVR TND</td>
<td>3,236</td>
<td>varies</td>
<td>530</td>
<td>10.1</td>
</tr>
<tr>
<td>DVR CSD</td>
<td>1,479</td>
<td>7,000</td>
<td>530</td>
<td>3.0</td>
</tr>
</tbody>
</table>

* units per land devoted to residential use

Case Study 2: Dove Valley Ranch (DVR)

For the Dove Valley Ranch (DVR) case study, an existing 575-acre CSD built north of Phoenix was compared to a hypothetical TND redesign at the same site. The DVR CSD buildout scenario was purely single-family residential; however, the DVR TND scenario includes a diverse mix of residential product types, more than twice the total number of residential units than the CSD alternative, a variety of community open spaces, and several mixed-use town centers.
Comparative Analysis: Overview

Each development scenario was engineered at a schematic level including thoroughfare typology analysis, streetscape design, parking analysis, and utility design. The engineering design ended at the building footprints – building foundations and cost of vertical construction were not part of this study. Once an estimate of infrastructure quantities was compiled for each development scenario, material quantities were multiplied by industry standard unit cost data and adjusted to account for regional cost variations. Design and engineering fees were not included.

Land Costs

Land costs were not factored into the analysis due to the desire to keep infrastructure cost comparisons distinct from land costs, which vary greatly and could disproportionately affect infrastructure conclusions. However, development configuration obviously has a significant effect on land costs. Utilization of lower density CSD development patterns requires additional land acquisition spending compared to a compact TND with the same development program.

Utilization of lower density CSD development patterns requires additional land acquisition spending compared to a compact TND with the same development program.

For example, if the total residential development proposed by the Belle Hall and DVR TND scenarios were built at the density of the Belle Hall and DVR CSDs, an additional 417 and 550 acres of land, respectively, would be required. This is more than twice as much land, even before taking into account the TND mixed-use areas where the same infrastructure is serving double-duty for commercial uses with residential units above. Higher residential density featuring interconnected street grids, mixing of uses, and parking efficiencies all lead to less land required for TND development.

II: COST RESULTS

Overview

Although numerous CSD and TND case study examples were evaluated, the following three direct comparisons were selected for presentation in this paper to isolate the effects of specific development variables.

- Belle Hall TND A vs. Belle Hall Large-Lot CSD B
  Using the same development program, a comparison of TND vs. Large-Lot sprawl.

- Belle Hall TND D vs. Belle Hall Smaller Lot Buildout CSD E
  Using the same development program, a comparison of transit supportive TND vs. CSD using smaller residential lot sizes comparable to that of TND.

- Dove Valley Ranch TND vs. Dove Valley Ranch CSD
  A comparison of built CSD single-family residential with a hypothetical TND demonstrating the land's potential.

In order to directly compare development scenarios with different development buildout, results presented in this paper were divided by the scenario's number of residential units to provide per-unit metrics. Belle Hall industrial areas were not included in the bottom line, since in each case study scenario they could be easily isolated. Infrastructure serving mixed-use areas of the Belle Hall and Dove Valley Ranch TND scenarios was counted as residential infrastructure so as not to unfairly benefit TND scenarios in the comparisons. Therefore, commercial development above residential can be considered a TND “bonus” where the same infrastructure serves multiple uses.

As mentioned previously, both Belle Hall Smaller-Lot scenarios (C & E) were determined to not be market feasible. Although CSD Scenario C did result in a lower per-unit infrastructure cost than TND Scenario A, the direct comparison of TND D with TND E is reproduced in this paper. The Belle Hall D/E comparison presents the buildout of transit supportive program over the entire Belle Hall buildable area, which was felt to be a more valuable illustration and comparative analysis from a market perspective due to the more appropriate TND density as discussed below.

Density

TND scenarios designed according to Smart Growth and New Urbanist principles with smaller lot sizes, compact urban form, a variety of multi-family housing types, and a mix of land uses results in infrastructure systems that serve more development in proportion to their cost to construct. In comparison, typical lower density CSD alternatives require far-reaching infrastructure systems to serve lower-density development, with higher costs to build. The case studies showed a clear reduction in infrastructure cost for scenarios with higher density.

The same TND infrastructure framework can support much higher densities due to the interconnected transportation network, mixing of uses, and parking efficiencies.

For example, directly comparing two scenarios with the same total development but different residential density demonstrated the cost premium for Large-Lot CSD infrastructure. Belle Hall TND A and CSD B scenarios have the same total development, but the CSD B scenario single-family residential lot size is approximately four times as large as that of TND A. The TND scenario results in a 35% per unit infrastructure cost savings compared to the Large-Lot CSD B scenario.

It is important to note that the same TND infrastructure framework can support much higher densities, such as that of the DVR TND and more, due to the interconnected transportation network, mixing of uses, and parking efficiencies. For example, density was added to the original Belle

2 Vertical construction presents a new set of architecture and market variables, and vertical construction costs are typically a separate element in a developer’s pro-forma.
3 Contact Morris Beacon Design or visit www.epa.gov/dced to obtain a copy of the full report completed for the EPA.
4 Seven residential units per acre (gross) is often cited as the minimum density to support public transportation. Those who argue for complete living neighborhoods as the building blocks for TND design and implementation would likely consider the Belle Hall TND A residential density of 4.5 units per acre, and perhaps even the Belle Hall TND D residential density of 7.9 units per acre, inadequate to support a healthy, complete, walkable neighborhood.
Hall TND framework simply by changing lot sizes and adding vertical floors. CSD land use patterns cannot adequately accommodate higher densities due to segregated land uses and dendritic transportation systems like that of the Belle Hall Buildout CSD E scenario.

**Urban Form**

The infrastructure construction cost premium commanded by CSD large-lot sprawl in comparison to compact TND is significant. However, many developers and builders interviewed for the EPA studies are using CSD development patterns (separated land uses, residential product type pods, disconnected auto-focused transportation systems) but with smaller lot sizes comparable to those of TND projects. Directly comparing scenarios with the same total development, similar residential lot size, and vastly different urban form, Belle Hall TND D compared with Smaller-Lot Buildout CSD E showed a 32% cost savings per unit for the TND scenario, and the Dove Valley Ranch TND resulted in a 47% cost savings per unit compared to the built CSD.\(^5\)

**Impervious Area**

Impervious area correlates strongly with both environmental impact and infrastructure cost. Antiquated zoning codes often require additional pavement, walks, driveways, and other impervious surfaces. In addition to the additional material cost for construction of impervious surfaces, more impervious area increases stormwater runoff volume and degrades water quality. As a result, higher costs are needed for more extensive stormwater management systems.

As shown above, compact TND forms of development result in far less impervious area per residential unit. These findings corroborate studies previously conducted by the EPA and others showing reduced impervious area for compact and interconnected Smart Growth and TND development patterns.\(^6\) Morris Beacon Design’s research for the EPA showed that TND alternatives resulted in an average of 42% less impervious area per unit than CSD alternatives.

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\(^5\) These savings do not take into account the “bonus” TND commercial uses supported by the same infrastructure.


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**Thoroughfares, Alleys, & Driveways**

A myth exists that a TND network of thoroughfares is inherently more costly than a disconnected CSD local/collector/arterial system due to the greater total length required for a grid system. Conceptually, the TND interconnected network includes thoroughfares on all four sides of a block, where a dendritic system of local streets, collectors, and arterials typically includes thoroughfares on only three sides (a collector with two cul-de-sacs). This oversimplified comparison is difficult to clearly resolve due to the myriad of variables involved, such as streetscape cost per linear foot of street, block size and configuration, land use patterns, and density. The TND grid network is usually part of a more efficient compact development pattern that provides for greater density, and the TND network also enables narrower thoroughfares and alleys utilizing less pavement per linear foot.

The infrastructure studies did show a greater total length in the TND systems when compared to CSD systems, with TND alleys essentially balanced by CSD driveways.\(^7\) For example, for the same total development there is a similar total thoroughfare length for the Belle Hall TND A scenario and the Large-Lot Belle Hall CSD B scenario, even though the developed area for the Large-Lot CSD B scenario is more than double that of the TND A scenario.

However, total length is only the first step towards the bottom line infrastructure cost. Potential savings gained by the reduced total thoroughfare length for CSD systems are in large part offset by the higher cost of wider CSD pavement sections. The TND compact and interconnected grid allows for more appropriate pavement widths and a greater variety of thoroughfare types. This is not possible in the CSD dendritic arterial/collector/local transportation model for several reasons:

- The CSD system funnels traffic to a small number of collectors and arterials, which typically require additional lanes to accommodate much higher demand.
- CSD thoroughfares are often required to be wider because they serve as the only route for emergency responders. The interconnected TND network allows for simple route adjustments through the grid if any one path is blocked.

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\(^7\) Although residential driveways are typically not included as part of a developer’s infrastructure cost, they were included as part of these studies to balance the cost of TND alleys and provide a fair comparison.
Parking

Even with narrower widths, TND thoroughfares satisfy a large percentage of parking demand with on-street parking. Reduced parking requirements and shared parking strategies due to mixing of uses and compact urban form also contribute to reduce parking requirements in TND developments by as much as 40-60 percent. CSD requires far greater investment in parking lots to serve single-use buildings in automobile only transportation networks. The figure below summarizes the total street and associated non-street costs (parking lots, residential driveways, and residential walks and patios) for each scenario.8

To summarize, TND scenarios generally require greater total thoroughfare length per residential unit in comparison to CSD scenarios with similar density. However, after adding the higher cost for wider CSD thoroughfares and for additional parking requirements, the comparisons change dramatically. The Belle Hall and Dove Valley studies found the total TND thoroughfares and parking cost per residential unit to be 30-46% less than that of CSD.

Summary

The bottom line results of the EPA comparative infrastructure cost study are reproduced in the figure below. The variables discussed in the EPA report including density, urban form, and impervious area led to a clear cost savings for TND infrastructure when compared with that of CSD. Since every development team has a list of internal motivations and external guiding forces affecting the form of development, the intent of this study is not to imply that the comparative cost savings found here would necessarily be replicable in every situation. However, the EPA study demonstrated that the costs can always be measured and compared, and the results showed far greater TND infrastructure cost savings than expected when compared to conventional suburban infrastructure costs.

Infill and Redevelopment

The most sustainable and cost-effective infrastructure solution is reuse of what has already been built. Infill development and reuse of underutilized buildings provides the lowest infrastructure construction and long-term infrastructure maintenance costs, and as importantly, redevelopment projects typically do not cause additional loss of natural resources. This study is not meant to state otherwise. However, experts predict 34 million new housing units will be built by 2030, and it is unrealistic to expect that a large percentage of these will be built within the existing urban framework. If a widespread move towards sustainable development is to happen, developers and high-production builders must consider both greenfield TND and infill as a desirable alternative to CSD.

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8 The DVR CSD scenario was entirely single-family residential, therefore there were no parking costs.
III: ADDITIONAL TND BENEFITS

The infrastructure case study completed for the EPA isolated the cost to construct infrastructure for TND and CSD buildout scenarios. Several additional benefits of TND development patterns were not factored into the analysis in order to keep the focus on infrastructure and density.

Open Space

There is a significant difference between open space used for community benefit such as plazas and parks, undeveloped and protected open space (natural resource areas), and residual open space. Open space for community use is an important feature of TND land planning, where small parks and squares fronted by buildings are located within walking distance of homes. This type of open space increases property values and internalizes that value to the developer. Undeveloped open space is natural area left untouched by development. In addition to the benefits of contiguous undeveloped open space provides for environmental, habitat, and viewsheild protection, it could also potentially be converted into a community amenity by introducing carefully designed low-impact walking trails. Residual open space is leftover naturalized or landscaped areas with little use to the community, such as buffer zones between CSD land use pods or landscaped areas between apartment buildings.

Park landscaping costs (TND) and municipal parks fees (CSD) were included in the infrastructure cost analysis but set equal so that they did not have an impact on the comparative total cost analysis. However, TND developers benefit from internalized open space for community benefit, where parks and squares raise property value.

Phasing and Risk Management

The infrastructure cost breakdowns for each of the development scenarios is helpful to evaluate the impact of various planning and design decisions on cost; however, it does not necessarily address developers’ implementation strategy. In addition to evaluation of the overall infrastructure cost, development phasing and risk management is a crucial component of the CSD/TND infrastructure comparison. Due to the compact nature of TND development and the inherent mix of uses, far less land and infrastructure is required to bring all residential and commercial products to market in a single phase. This translates into less carrying cost and shorter risk horizon per phase. If adjustments to the residential product mix are necessary due to a changing market, adjustments can be made incrementally. Due to the pod-like segregation of residential product types and sprawling infrastructure, CSD development patterns are far less flexible and require greater initial investment and risk.

Stormwater management

Sustainable stormwater management mimics a site’s natural hydrology by utilizing small-scale, decentralized measures that slow, treat, and infiltrate runoff at its source. Whereas in the traditional “curb and gutter” approach, all runoff is collected and conveyed to a centralized detention/treatment facility and discharged offsite.

Sustainable stormwater management practices were not incorporated into the studies. It was determined that while strongly supported by the EPA and Morris Beacon Design, incorporating innovative sustainable stormwater management strategies into the methodology would unnecessarily shift attention from the primary focus of this study: density and arrangement of infrastructure. Although the engineering industry continues to adopt innovative stormwater management techniques as an alternative recommended practice, sustainable stormwater management techniques are not yet universally utilized as standard engineering practice and therefore were not utilized in this study.

The case studies completed for the EPA found that even though urban stormwater management techniques are sometimes more costly than those for suburban development patterns, reductions in impervious area per unit for TND scenarios led to far less total runoff, and therefore less total cost for mitigation of runoff rate, runoff volume, and stormwater quality.9

9 Stormwater management techniques, effects on the water balance, and treatment of runoff for water quality will be examined in an upcoming Morris Beacon Design study entitled “Smart Growth and the Watershed - A Comparative Case Study”.

Acknowledgements

Special thanks to Dover Kohl & Partners for generously providing Belle Hall project site information including the initial CSD & TND scenario plans, William Gietema, Arcadia Development Company, for providing valuable developer review and feedback, and to Peter Swift, PE, for his design of the Dove Valley Ranch TND.
With unique dedication to the principles of Traditional Neighborhood Design, Smart Growth, and New Urbanism, Morris Beacon Design integrates sustainable neighborhood design with civil engineering detail.

**Walkable Street Design**  Morris Beacon Design implements Smart Growth by providing context sensitive thoroughfare analysis, network layout, and detailed streetscape design to facilitate neighborhood connections both physical and social.

**Sustainable Infrastructure**  Morris Beacon Design produces reports, plans, and calculations to incorporate eco-sensitive neighborhood design principles and sustainable site engineering best practices into projects of all sizes.

**Master Planning**  Morris Beacon Design works side by side with the design team’s architects, urban designers, and town planners to develop plans that are feasible and constructible.

**Charrette Support**  During the planning and design of new projects, Morris Beacon Design serves as a liaison between the charrette team and local engineers, planners, and the general public while serving as a design resource during plan development.

**Implementation**  A consensus master plan is too often compromised when it comes time for detailed engineering & construction. Morris Beacon Design provides integrated site layout, grading, and utility design services to develop construction documents for New Urbanist & TND projects without sacrificing the intent of the master plan, and can also liaison with local engineers to ensure proper execution.

**Comparative Infrastructure Analysis**  In order to quantify the financial impact of TND planning and implementation, Morris Beacon Design can design TND and conventional suburban alternatives for your project and compare the infrastructure cost for each.