Chapter 4
Stream Protection Clusters

Introduction

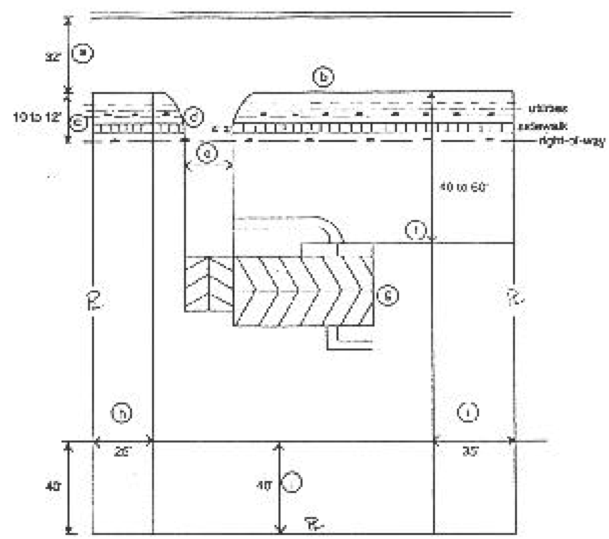
This chapter explores the use of cluster development as a means to reduce impervious cover at development sites. Cluster development refers to a more compact pattern form of development. Conventional sub-division lot dimensions are relaxed to allow more dwelling units on one portion of a site to reserve undeveloped space elsewhere on the site.

Clustering is not a new idea. Planners have utilized it for several decades in many communities around the country. Most cluster programs, however, were developed to meet general environmental, architectural or community objectives and were not specifically designed to reduce site imperviousness (Heraty 1992). This chapter suggests how these traditional cluster development regulations can be adapted to protect streams.

Some Cluster Geometry and Terminology

Cluster development is an alternative site planning technique that concentrates dwelling units in a compact area of the total development site. This form of development can reduce the impervious cover at a site, protect environmentally sensitive areas and provide more open space in a community. Clustering is accomplished by trading a greater density of homes on one portion of a site in exchange for reduced density elsewhere. Greater density is achieved by allowing site designers to reduce the dimensions and geometry of individual lots, and shortening the road network (MWCOG 1995). In order to design effective cluster development, it is necessary to understand some of planning terms that help define the number and geometry of lots in a subdivision. Figure 16 illustrates the typical geometry of an individual lot.

FIGURE 16: GEOMETRY OF A TYPICAL ONE ACRE LOT



a	minimum street width 32'	f	front yard setback minimum 40-60'
b	minimum lot frontage 150'	g	lot foot print - 5% minimum
c	minimum right-of-way 10'	h	side yard setback 25'
d	minimum driveway width 4'	i	side yard setback 35'
e	minimum driveway width 20'	j	rear yard setback 40-60'

Local subdivision codes impose sharp restrictions on the allowable geometry of a lot.

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Conventional zoning standards usually dictate that each lot have a minimum area, specify each home must be setback a fixed distance from front, side and rear property lines, and require a minimum frontage width (i.e, mandatory width of the front yard). Together, these standards tend to increase the total size of each lot, which in turn increases the distance between lots. The length of roads, sidewalks and other impervious surfaces is directly correlated with the distance between lots. Thus, as the distance between lots is extended, more impervious cover will be created.

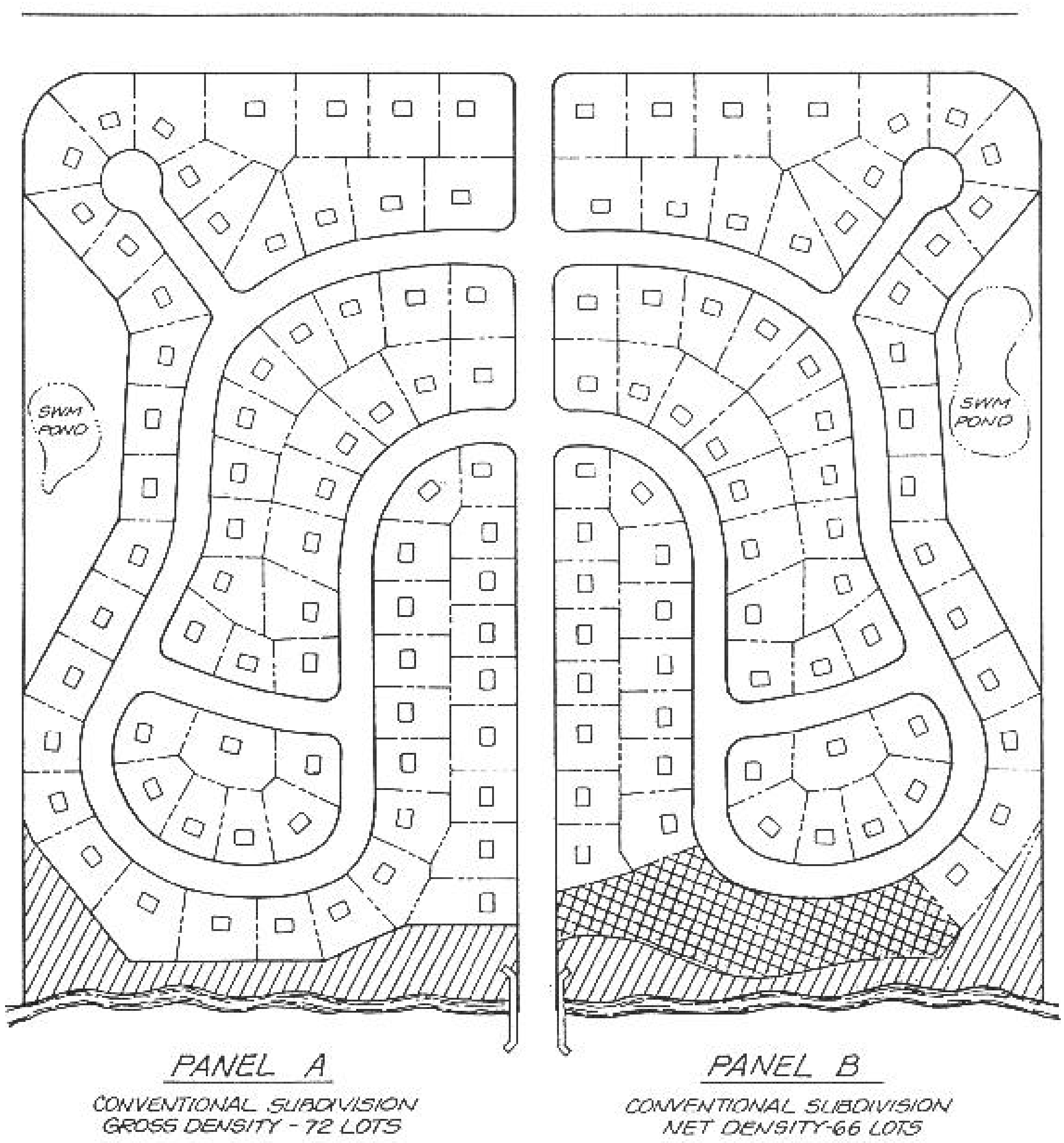
Next, it is useful to explain concepts relating to the density of development. To begin with, each site is subject to a zoning classification. The zone sets forth the maximum or *gross density* allowed for a site, expressed in terms of dwelling units per acre. In the hypothetical example portrayed in Panel A of Figure 17, a 72 acre residential property is zoned at one dwelling unit per acre. Consequently, the builder is permitted to construct 72 individual homes on the site.

However, some communities require that the gross density be adjusted to subtract out any *unbuildable land* on the property site. These are areas where structures cannot be located because of physical or environmental constraints (e.g., easements, open water, steep slopes, wetlands or floodplains). Once these lands are subtracted out, we obtain the *net density* allowed for the site. Using our hypothetical site again, we see that six acres of unbuildable land are located on the site in the form of the floodplain and a wetland. (Figure 17, Panel B). Thus, our net acreage is computed as (72 – 6) = 66 acres. This new acreage is then multiplied by our one dwelling unit per acre density to arrive at a total of 66 actual lots.

Once net density is computed, the next step is to configure a site as a cluster. Typically, a community requires a cluster development to reserve a minimum proportion of the site as *open space*. According to Heraty's survey, the average open space requirement is 33%, with a range 10 to 50%. Arendt (1994) notes that some communities impose an 80% requirement in large lot zones. Open space is generally reserved as a single, contiguous unit. Some fraction of open space must be retained as *"green space,"* i.e, in an undisturbed vegetative condition, while the remainder is considered "*community space*," suitable for recreation, landscaping, turf or stormwater treatment. All open space is legally protected from future development, and allowable uses and activities within in it are clearly prescribed in a binding community maintenance agreement.

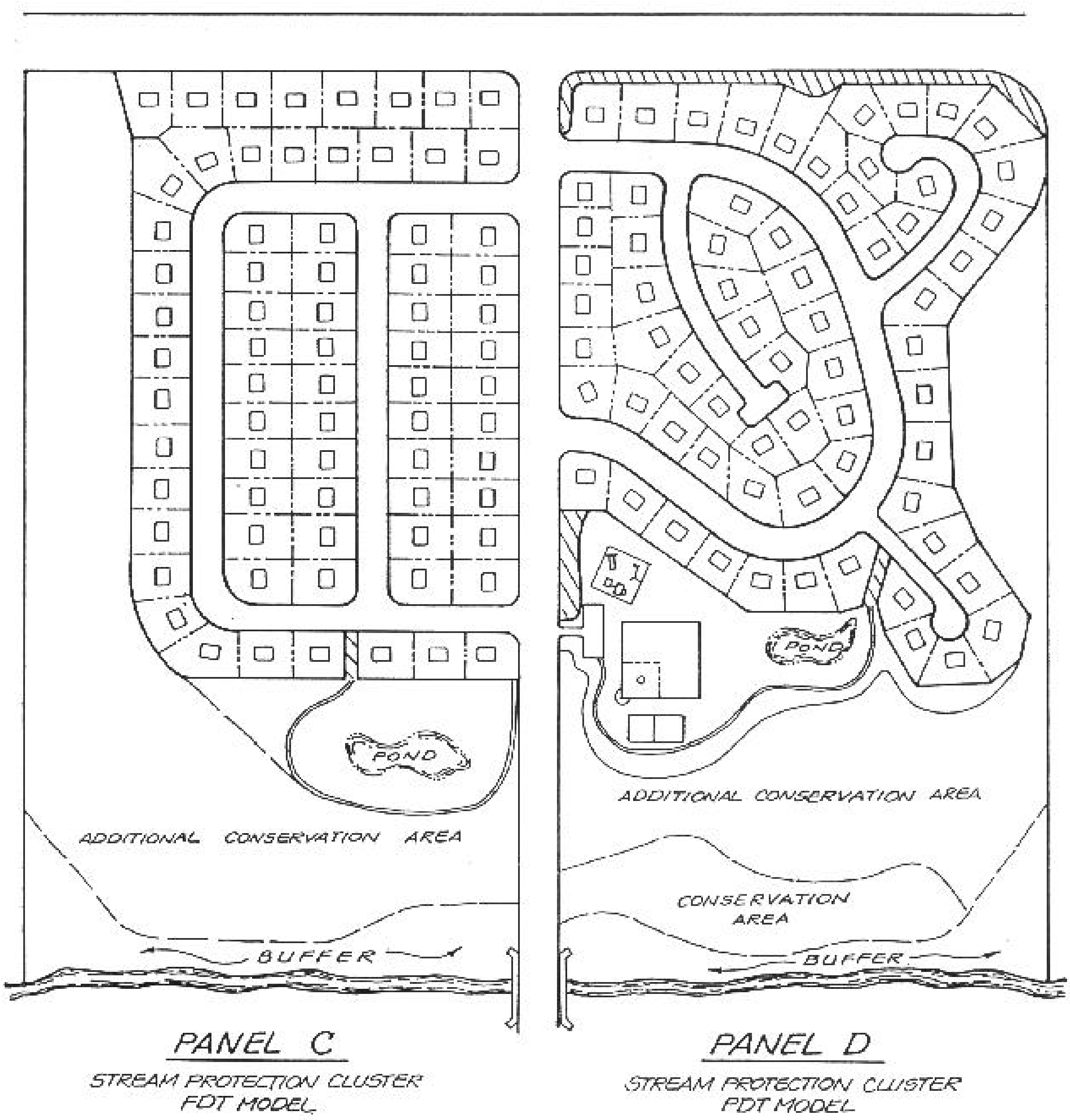
A designer then works with the remaining portions of the site to locate the allowable number of lots, given the net site density. The planning authority, in turn, gives the designer flexibility to reduce lot size, setbacks and frontage requirements on the remainder of the site. In some cases, the local planning authority may also allow a designer to share driveways or septic systems between individual lots.

FIGURE 17: IMPLICATIONS OF GROSS AND NET DENSITY DEFINITIONS ON A DEVELOPMENT SITE



17 A. Conventional subdivision pattern with 72 equal sized lots (Panel A). The number of lots on the parcel drops to 66, because six acres of floodplain and wetland (hatched lines) are considered to be unbuildable land, and must be subtracted from gross density (Panel B).

FIGURE 17: IMPLICATIONS OF GROSS AND NET DENSITY DEFINITIONS ON A DEVELOPMENT SITE



road network, thus saving green space (Panel C). In the PDT model, 66 units are clustered on smaller lots using a curvilinear road network, providing common green and community space (Panel D).

Designing a Stream Protection Cluster

The intent of a stream protection cluster is twofold. First, it is designed to measurably reduce the amount of impervious cover created compared to traditional development patterns. Second, it retains a significant fraction of total site area as permanently protected green space.

We can now define two basic options for stream protection cluster, based on how a community defines unbuildable land and net density (Table 12). The two options are:

Full Density Transfer and
Partial Density Transfer

The differences between the options are outlined in Table 12.

In *Full Density Transfer (FDT),* a community does not recognize the concept of unbuildable land when computing net density. Thus gross density is equal to net density. A typical FDT cluster is shown in Panel C of Figure 17. The original 72 lots are still built on the parcel, but they are smaller in size, and require a shorter road network. Nearly half of the parcel is managed as community open space, which provides ample room for resource protection areas, stormwater ponds and recreational needs. In this particular example, the designer has chosen a grid–like road network to link individual lots, which results in the shortest possible road length. The key advantage of the FDT option is that it allows developers to partially increase density on one portion of a site to compensate for the inability to build on another, due to wetlands, floodplains, stream buffers, steep slope or stormwater requirements. In the FDT option, the rooftop component of imperviousness does not change from the original zoning, but the transport component is often reduced due to the shorter road network.

In *Partial Density Transfer (PDT),* a community defines land areas that are considered unbuildable for physical and environmental reasons, and subtracts these from the gross density to arrive at net density. The allowable number of lots is reduced, and the developer is not compensated for them. Under the more restrictive PDT option, impervious cover can be reduced by a greater extent. (since rooftop *and* transport components of imperviousness are both reduced). A typical example of a Partial Density Transfer Cluster is shown in Panel D of Figure 17. Here, the developer has constructed the 66 units allowed under net density, and has created a large area of open space and green space to be managed by a homeowners association. A narrow, curvilinear road design connects individual lots, which produces 50% less imperviousness than the non–clustered layout (Panel B, Figure 17).

The choice of which cluster option is acceptable in a community depends to a great extent on the political history of environmental and development regulation in a community. In some regions, it would be unthinkable to ever subtract unbuildable land from gross density, while in others, density reduction is routinely accepted.

TABLE 12: COMPARISON OF TWO STREAM PROTECTION CLUSTER OPTIONS

Planning Factor	Full Density Transfer	Partial Density Transfer
Net density computed:	Net density is equal to gross density	Net density is equal to gross density - unbuildable land
Resource areas are protected in the:	In the open space area	Unbuildable land connected to open space
Roof imperviousness:	Stays the same	Decreases
Transport Imperviousness:	Decreases	Decreases
Green space provided:	A proportion of open space not dedicated to active recreation (AR)	RPAs, buffers, and the proportion of open space not in AR
Green space:	No less than 70% of open space	No less than 50% of open space and unbuildable land
Community space:	No more than 30% of open space	No more than 50% of open space
Minimum open space:	50 to 80% of site	33 to 50% of site

It is important to distinguish FDT and PDT options that are oriented toward reducing impervious cover, from "bonus" cluster options, that do not. Under bonus clusters, a developer is granted a density credit or "bonus" over and above the original gross density, in order to promote affordable housing, attract development in minority areas, or serve as a receiving area for transfer of development rights (e.g., farmland preservation). While density bonuses may be desirable from a socio–economic standpoint, they generally do not confer many stream protection benefits, and therefore, are not discussed further.

Benefits of Cluster Development

Well designed and implemented cluster developments can provide many important economic, environmental and community benefits when compared to conventional subdivision designs (Table 13). For example, cluster developments can:

1. Reduce site and watershed imperviousness by 10 to 50%

Cluster development is an excellent technique to reduce impervious cover at both the site and watershed level. The exact reduction in impervious cover depends on the size and

TABLE 13: BENEFITS OF CLUSTERING DEVELOPMENT

1. Reduces site imperviousness by 10 to 50%, depending on the original lot size and road network
2. Reduces stormwater runoff and pollutant loads
3. Reduces potential pressure to encroach on resource and buffer areas
4. Reduces soil erosion potential since 25 to 60% of site is never cleared
5. Reserves 25 to 50% of site as green space that is not required in conventional subdivisions
6. Reserves 15% of site in open space dedicated to passive recreation
7. Provides partial or total compensation for lots that may be lost when land is reserved for resource protection areas and stream buffers
8. Reduces capital cost of development by 10 to 33%
9. Reduces the cost of future public services needed by the development
10. Can increase future residential property values
11. Reduces the size and cost of stormwater quantity and quality controls
12. Concentrates runoff where it can be most effectively treated
13. Provides a wider range of feasible sites to locate stormwater BMPs
14. Creates larger urban wildlife habitat "islands"
15. Increases sense of community and pedestrian movement
16. Can support other community planning goals, such as farmland preservation, affordable housing, and architectural diversity

configuration of each individual development site. Studies have shown that total site imperviousness can be reduced by 10% to 50% when compared to conventional subdivision layouts. (Maryland Office of Planning 1989). The greatest reduction in impervious cover generally occurs when larger lots are clustered (1du/ac or larger), although significant reductions can still be realized in medium density residential development (2 to 6 du/ac).

The amount of reduction in impervious cover is primarily due to the shorter length of road network needed to serve individual lots (Land Ethics 1994). In clusters, the distance between individual lots is smaller, so that a given length of road can serve a greater number of lots. Also, the road network must be shorter because it generally will not cross open or green space.

The cumulative effect of clustering in reducing impervious cover at the watershed level has yet to be systematically examined in any community. It is expected, however, that the cumulative reduction in imperviousness at the watershed level will be slightly less than that achieved at an individual development site for two primary reasons. First, many developments are too small to be effectively clustered and therefore cannot contribute to any watershed imperviousness reduction. Second, since cluster is a voluntary development option, not all of the eligible development sites actually employ clustering.

2. Reduce stormwater runoff and pollutant loads

As noted in Chapter 2, the generation of stormwater runoff and pollutant loads from a development site is a direct function of site imperviousness. Consequently, the rate and volume of runoff and the pollutant load can be reduced by 10 to 50% from a development site from conventional layout. Other researchers have computed the impact of cluster versus traditional subdivisions layouts using the Simple Method and have found similar results (MOP, 1989).

3. Reduce encroachment pressures on resource and buffer areas

Most conventional subdivision codes do not require that a developer reserve any land for open space. At the same time, local requirements to protect resource areas, such as wetlands, forests and streams and their buffers, result in the loss of potential lots at the site. Local stormwater requirements may also consume developable land. It is not very surprising, then, that conventional development patterns create intense pressures to encroach on these areas.

Cluster development, on the other hand, reserves from 30% to 80% of the entire site as open space, while keeping the same number of total lots on the site (which are now smaller in size). This reserve of open space is usually large enough to accommodate most required resource protection areas, buffers and BMPs on the site without losing any developable lots. As such, clustering provides developers some compensation for complying with resource protection and buffer requirements. The FDT option provides full compensation, whereas the PDT option may only provide partial compensation.

4. Reduce potential for soil erosion

Depending on the option used in stream protection clustering, anywhere from 25% (PDT) to 60% (FDT) of total site area is reserved as green space. Since green space cannot be disturbed or cleared during construction, the potential sediment control benefit is impressive. To begin with, erosion only occurs after a site is cleared, and soils are exposed to the erosive force of rainfall. Once soils are exposed and eroded, they can deliver sediment concentrations in excess of 4,000 mg/l to a stream. Even with the most effective erosion and sediment controls, a construction site still delivers sediment concentrations to the stream on the order of 200 to 300 mg/l, or about ten times greater than those found in undeveloped streams (Schueler and Lugbill 1991).

Since clustering prevents clearing on a large portion of the site, total sediment loads delivered to the stream during construction will be reduced accordingly. This form of "pollution prevention" not only reduces erosion potential but can result in significant cost savings for the developer. For example, the cost to clear each acre of forest and install and maintain sediment controls can exceed $5,000/ac. (SMBIA 1990).

5. Reserve 25% to 50% of site in green space that would not otherwise be protected

Most conventional subdivisions are not required to have green space, apart from private bufferyards, setbacks or lawns. By way of contrast, clustering can result in green space protection for a large portion of the total site area. Regardless of what cluster option is used, most cluster site plans protect more green space than is required under local or state permitting programs. Consequently, a greater range of landscapes and habitat types can be protected, particularly prime woodlands, croplands and critical habitats, that are not often accorded any special protection under local or state law. The consolidation requirement also helps ensure that green space is contiguous with resource protection areas and the buffer network, and is not fragmented into smaller units.

6. Reserve up to 15% of site in community space dedicated to passive or active recreation

Cluster developments typically provide recreation areas that constitute up to 15% of total site area. Conventional subdivisions provide none. Recreation areas in clusters can be either passive or active, and may consist of athletic fields, tennis and basketball courts, playgrounds, pools, bike trails and other community amenities. Although many of these recreational uses can create additional impervious area, they also contribute to a sense of community and may increase property values. In addition, the existence of recreation areas relieves some of the inevitable pressures to encroach on adjacent green space.

7. Reduce capital cost of development by 10 to 33%

Cluster development is much cheaper to construct than conventional development. To begin with, nearly half of the total capital cost involved in constructing a large–lot subdivision is for infrastructure rather than the building of individual homes. (Frank 1989 and Table 14). Some of the routine components of subdivision infrastructure include:

- local streets and roads
- sanitary sewer collection system
- storm sewer collection system
- water distribution system
- sidewalks
- streetlights
- street trees

TABLE 14: THE COST OF DEVELOPMENT INFRASTRUCTURE AS A FUNCTION OF DENSITY COST PER LOT, 1992 DOLLARS (ADAPTED FROM FRANK, 1989 AND CH2MHILL, 1992)

Land Use Category	Schools & Utilities (*)	Subdivision Infrastructure (#)
SFR (1 DU/acre)	$16,500 per lot	$33,700 per lot
SFR (3 DU/acre)	$17,300	$17,500
SFR Cluster (5 du/ac)	$18,900	$10,200
Townhouse (10 du/ac)	$15,600	$7,200
Garden Apts. (15/ac)	$14,700	$4,600
Hi Rise Apts (30 dus)	$6,400	$2,200

Notes: SFR= single family residential
(*) includes primary and secondary schools, and gas, electric and telephone connections
(#) includes all streets and roads, sidewalks, sewer, water, and storm drain/management systems

The unit cost for each of these infrastructure components is directly related to the distance between individual lots (see Table 5). As the length between individual dwelling units decreases, the total cost of subdivision infrastructure declines proportionately (CH2MHILL 1992). While some development costs are relatively fixed (bonds, fees, lot clearing and grading, boundary topography, engineering stakeout, etc), at least 60% of development costs are variable (i.e., their unit cost is directly related to the length and layout of development).

The cost savings can be very attractive. The greatest savings generally occur when large lot subdivisions are clustered (1 du/ac or larger). Land Ethics (1994), NAHB (1986), Frank (1989), and MOP (1989) all report cost savings of 25% or more associated with clustering large lot developments. Savings are not as great when smaller lots are clustered. For example, SMBIA (1990) indicate a cost saving of only about 10% when half acre lot zones are clustered (minimum lot size drops from 20,000 square feet to 10,000 square feet).

8. Reduce cost of future public services to the community

Once all the homes in a subdivision have been sold, the new residents create a demand for additional community services, including schools, police and fire protection, libraries, and roads. Residential development tends to have a greater fiscal impact than other land uses, requiring more local services than they return in property taxes (Vance and Larson

1988) with the greatest disparity recorded for large lot development (American Farmland Trust 1986 and NAHB 1986). While the demand for many public services is relatively insensitive to lot size or density (schools, police, fire, libraries etc), the public service costs of compact cluster developments were still 4 to 8% less than large lot developments, primarily because of shorter lengths needed for water and sewer distribution and arterial roads (CH2MHILL 1992). Cost savings decline when residential developments are located farther away from employment centers or water and wastewater treatment plants.

A community also has a keen interest in the property tax yield from individual lots. Clustering can have a positive impact on local property tax yield. Extensive analyses of property tax yields in 23 suburban Maryland counties indicate that the average per acre market value for improved residential parcels declines as the size of the parcel increases (MOP 1989). For example, the average tax yield increased from $423 *per acre* for large five acre lots to some $5,171 *per acre* for more closely spaced lots (quarter acre lots), for the simple reason that there are more property taxpayers per acre. On the other hand, it should be noted that the property tax collected *per dwelling unit* declined from about $2,100/yr in the larger lots (0.2 du/ac) to some $1,300/yr for the more closely spaced lots (4 du/ac).

9. Increase future residential property values

Another key factor influencing the use of clustering is whether property will appreciate in value over time compared to conventional subdivisions. While a host of factors influence future residential property values, some evidence indicates that homes located adjacent to well designed and maintained open or green space do appreciate at a faster rate than traditional residential subdivision properties. This premium has been found to range from 5 to 32 percent, according to Land Ethics (1994). Another study in Massachusetts indicated that homes in cluster subdivisions with open space appreciated 13% more in value, than similar homes in conventional subdivisions, over a 21–year period (Lacy and Arendt 1990).

Over 80% of respondents in Heraty's cluster program survey (1992) felt that cluster property appreciated at a higher or equal rate compared to a conventional subdivision.

10. Reduce size of stormwater quantity and quality controls

Under most local stormwater criteria, the required storage volume for stormwater quantity and quality control is directly related to the total impervious cover of the contributing watershed. Thus, a significant reduction in impervious cover caused by clustering (10 to 50%) will result in smaller stormwater quantity and quality controls than would otherwise be needed. In addition, the size, extent and capacity of the storm drain network can also be reduced at the site. A developer can realize significant cost savings in this area. As one example, a developer can reduce the cost for stormwater quality controls by $500 to $1,000 for each acre of impervious area that is eliminated through clustering (Wiegand et al. 1986).

11. Concentrate runoff where it can be effectively treated

Another benefit of clustering is that it concentrates stormwater runoff into one portion of a site. This allows a stormwater designer to treat the runoff at one or two points in the development site, usually in a stormwater pond.

Contrast this situation with conventional subdivision layouts. Runoff is generated over the entire development site. Often, site topography dictates that the runoff be conveyed to many different outfall points, each of which must be served by an effective practice. As a result, conventional subdivisions often are served by many small, widely scattered BMPs. It should be noted that concentration of runoff may not always be desirable, particularly if clustering precludes opportunities for disconnecting impervious area and providing open channel drainage.

12. Provide a wider range of possible sites to locate stormwater BMPs

Clustering reserves a large quantity of land at the site in open space. The availability of so much land affords a site designer a greater range of locations for stormwater practices. An ideal site for a pond or wetland is often a location that captures the maximum upstream contributing area, or has topography that reduces the need to excavate. An ideal site may also be the most visible or attractive open space to place a stormwater pond or wetland in the community. In any event, clustering clearly gives the designer more choices for BMP location. These choices can have positive economic benefits for developers. A summary of over 20 real estate pricing studies indicate that well designed ponds and wetlands can command a $10,000 per lot premium (Frederick 1995) and increase rental rates for both offices and apartments.

BMP choices are sharply constrained in conventional subdivisions, since no significant open space is available. Almost invariably, land devoted to a stormwater BMP is land taken away from developable lots. Thus the designer is under enormous pressure to shoehorn a system into an unutilized area of the site. Consequently, many of these devices suffer from poor maintenance access, inadequate internal geometry and overall reduced performance.

13. Create urban wildlife habitat areas

Many urban and suburban residents express a strong preference to live adjacent to natural and undisturbed open space for purposes of nature enjoyment and wildlife watching. Large, consolidated blocks of green space found in cluster development can support considerable diversity of mammals, songbirds and other wildlife. When green space is combined with habitat areas of urban stream buffer network, the total size of the habitat island can be sharply increased.

14. Increase sense of community

Clustering has the potential to increase the sense of community in a residential development for a number of reasons. First, the landscape architect has a diversity of options to plan recreation and open space and thus create attractive and safe common areas where residents can mingle together. Second, since the open space must be managed by a homeowners' association, there is a greater chance that residents will think of their community as a distinctive place where they participate.

15. Support other community planning goals

Cluster development was originally designed to support other community planning goals such as preservation of farmland or the rural character of the landscape. In other areas it has been used to produce a greater stock of affordable housing or to promote greater architectural diversity and styles within a community. Other planners have seen cluster development as one element of a regional strategy to reduce the number of vehicle miles travelled and thus avoid or reduce the impact of congestion on air quality and traffic.

Local Experience with Cluster Development

What has been the real experience of communities over the past two decades? Our most detailed knowledge about local cluster programs is drawn from a national survey of 39 programs conducted by Heraty (1992). The responses from a wide cross–section of planners suggest that many current cluster programs may require significant modification if they are to achieve effective stream protection. Survey results are supplied in Appendix A, and several key findings are outlined below.

1. Cluster developments are rarely designed for the purpose of protecting streams or providing nonpoint source control

Most local cluster programs were adopted for purposes unrelated to stream protection or urban nonpoint source control. Indeed, the five most frequently cited objectives for cluster were to (1) achieve a greater variation in the style and design of residential developments (80%), (2) protect environmentally sensitive areas, primarily wetlands and forests (77%), provide recreation areas (62%), preserve the rural character of the landscape (51%), and produce more affordable housing (39%).

Only 18% of cluster programs were specifically adopted as a means of reducing stormwater pollution from the site, or as a technique to reduce impervious area. Most of the respondents, however, acknowledged that clustering did reduce impervious cover, when compared to conventional subdivisions.

2. Communities have widely different definitions of net site density

The survey indicated that communities were split on how they defined net density in residential development. About 40% of cluster programs employed the full–density transfer option (i.e., FDT = gross density is equivalent to net density), whereas about the same number utilized the partial density transfer option (PDT) (net density was equal to gross density less any land that was unbuildable for environmental or physical reasons). The definition of what constitutes unbuildable land, however, was not consistent among the 39 cluster programs surveyed by Heraty (Table

15). Indeed, over 40% of cluster programs do not even recognize the concept of unbuildable land when determining the allowable number of lots that can be clustered.

About 15% of the cluster programs surveyed provided extra density bonuses (beyond gross density), creating the possibility that impervious cover might actually increase in some sites due to cluster.

3. Required open space in clusters is often poorly designed and fragmented

Nearly every cluster program required that some portion of the site be retained as open space. On average, the minimum requirement for open space was one–third of total site area

TABLE 15: SURVEY OF COMMUNITY DEFINITIONS OF BUILDABLE AND UNBUILDABLE LAND

Land Category	% That Define it Unbuildable
Existing Right of Ways/Easements	77%
Wetlands	71%
Floodway or Floodplains	65%
Surface Water (lake, pond, etc)	59%
Steep Slopes	53%
Buffers	29%
Prime Woodlands	29%
Open Space for Recreation	12%
Private Internal Roadways	12%
Prime Agricultural Soils	6%
Drainageways	6%
Shorelines	6%
No Subtractions	41% of cluster programs do not subtract any unbuildable areas from the site (gross=net)

As can be seen, communities show considerable variation in the land they define as unbuildable. The more land considered unbuildable, the less density that can be transfered. (Source: Heraty 1992).

for residential development. Many communities cited a recurring problem with the poor quality and fragmentation of open space. In some cases, open spaces were poorly landscaped and widely scattered across the entire development in small bufferyards, dead pockets and frontage. Consequently, the open space provided little functional value for either the community or the environment.

As a result, a third of all cluster programs now require that a minimum percentage of open space should be consolidated together. The average consolidation requirement is 70% of total open space (range 30 to 100%). Even those communities that did not currently require open space consolidation thought that such a requirement would improve the quality of their clusters.

About a third of all cluster programs also specified that a portion of open space must be dedicated to active recreation. Typically, recreation areas comprised about 30% of total open space. This requirement reflects the fact that homeowners desire active recreation areas and if these areas were not provided, homeowners would encroach into green space anyway.

4. Few cluster programs currently require that a portion of open space should be protected as green space

It is interesting to note that very few cluster programs (less than 10%) currently require that any portion of open space be reserved as "green space" or undisturbed natural areas. Some cluster programs (about 25%) had an indirect green space requirement, in that certain environmentally sensitive areas such as wetlands, steep slopes, or floodplains were automatically included in open space.

5. Cluster programs rarely specify what are allowable and unallowable uses of open space

A great deal of variation was seen in the kinds of uses and activities that were allowed (or denied) within designated open space. Table 16 illustrates the variability in allowable and prohibited uses of open space in local cluster programs. As can be seen, a surprising number of allowable uses create impervious cover (such as hard courts, pools, roads, bike paths). Only 14% of all programs restricted or prohibited significant impervious cover within green or open space.

Most cluster programs allowed golf courses, lawn, turf, ballfields and fill within open space. While these uses are acceptable within open space dedicated to recreation, they do not afford protection for green space. Very few cluster programs acknowledged this key distinction.

Lastly, about two–thirds of local cluster programs allowed stormwater BMPs to be located within open space. About 20% required that BMPs be located only on a certain type of open space, and 16% prohibited their use within open space at all (usually requiring that they be located on unbuildable land). Many communities allowed common on–site sewage disposal systems to be located in open space, but a majority prohibited the placement of individual septic systems.

Table 16: Allowable and prohibited uses of open space (adapted from Heraty 1992)

Land Use or Activity	Allowed	Prohibited	Restricted (*)
Parks (incl. foot or bike	94%	3%	3% (RO)
Athletic Field	49%	15%	36 % (RO)
Golf Course	67%	11%	22% (RO)
Hard Courts	53%	12%	35% (RO)
Playground	58%	8%	34% (RO)
Swimming Pool	50%	9%	41% (RO)
Impervious Surfaces	86%	14%	--
Individual OSDS	16%	78%	6% (P)
Common OSDS	41%	53%	6% (P)
Road/Bridge	55%	39%	6% (P)
Utility Lines	70%	18%	12% (P)
Lawn or Turf	71%	14%	6% (P), 9% (RO)
Stormwater BMPs	65%	16%	14% (GS), 5%
Agriculture	29%	--	--
Community Center Bldg	14%	--	--
Trails	39%		
Placement of Fill	55%	29%	10% RO, 6% P
Notes: RO=in recreational areas only, GS=only in green space, P=use is restricted, may require permit or homeowner association approval			

Communities need to go beyond merely requiring open space, they must make key decisions as to what uses or activities are allowed to occur within it.

6. Clustering remains a largely voluntary development option, that is not frequently exercised by the development community

Clustering is a non–mandatory option in 95% of the local cluster programs surveyed. On average, about 37% of all new subdivisions are clustered in communities, with the remainder conventionally developed. Surprisingly, 20% of communities reported that they had yet to receive a cluster proposal since they first adopted their cluster ordinance. Other communities report from 5 to 100 cluster proposals per year.

A number of market factors and perceptions explain the wide variation in the number of developers that opt to cluster. For example, developers need to balance the perceived economic benefits of building cluster against the vagaries of the real estate market (i.e, will clustered units sell?). After all, the conventional subdivision product has sold well over the years—will a clustered product be equally accepted in the market? Many respondents remarked that consultants, bankers, landscape architects and developers all needed to be reassured on this point before it becomes a common practice.

A host of consumer preferences also influence market acceptance of cluster developments. Some consumers favor clusters for their enhanced recreational open space, natural character, and common amenities. On the other hand, some housing consumers feel that the smaller lots and proximity to other homes diminishes privacy. Others may not be comfortable with the additional costs and property restrictions associated with homeowners' association management. Overall, the actual market acceptance varies depending on the type of housing and the quality of clustering.

From a cost standpoint, much of the development community now recognizes that clustering can save capital costs in construction, provide partial compensation for lost lots due to local, state or federal regulation, and provide greater architectural variety. As noted before, many developers recognize that well designed and implemented cluster developments can compete in the market.

Still, concerns linger among developers. For example, there is a strong perception that clusters will be scrutinized more closely than traditional "cookbook" developments. Others are concerned that final approval be more difficult to obtain and community opposition greater. In particular, neighbors may view a cluster development as something of a Trojan horse, out of which will pour extra traffic and congestion. Communities often require that clusters must follow a special exception process, that may include formal public hearings or longer review processes for some plans. Lastly, developers often perceive that cluster development requires a greater investment in planning, design, and submittal requirements compared with traditional subdivisions.

This suggests that local governments may need to provide a wider range of incentives to the development community, if the proportion of subdivisions that are clustered is to be increased from present levels. Over 50% of planners acknowledged that greater efforts are needed to encourage developers to consider implementing cluster in their projects. Some of the more frequently cited incentives include an expedited review process, more flexibility in design and density, and a greater investment in education and training of consultants and landscape architects.

7. Poorly conceived or implemented cluster developments can cause controversy in a community

Clearly, it is possible to design a lousy cluster development. Heraty's survey (1992) revealed a wide range of complaints about poorly conceived or implemented clusters. The complaints generally fell into one of four categories:

a. <u>Poorly planned open space</u>
The most common complaint was that open space was poorly planned, inadequately maintained, or too fragmented. Approximately half of all cluster program respondents felt that landscaping requirements for open space should be enhanced. Others felt that open space did not adequately protect all natural areas in the development.

b. <u>Neighborhood opposition</u>
Some adjacent residents felt some cluster development did not always blend with adjacent residential zones and generated too much traffic or noise. Another recurring concern was the perception that the cluster would result in a greater density for the site than would have been otherwise allowed under a conventional subdivision.

c. <u>Resident concerns</u>
Many resident complaints about cluster developments are focused primarily on roads and parking. Several cluster programs reported complaints about parking (either too much or too little), poor traffic circulation, and inadequate maintenance of private roads. Other complaints centered on the cost of private maintenance of infrastructure and open space.

d. <u>Poor construction practices</u>
Destructive practices include excessive clearing, tree removal, poor erosion and sediment controls and improper fill. It should be noted that most local governments also report problems in each area for conventional developments (Corish 1995).

8. Communities have usually found it necessary to revisit their cluster programs

Few cluster programs are recognized as being perfect. Over half of all cluster programs have seen the need to revisit their cluster programs. In the majority of cases, the changes increased the quality of cluster programs.

9. A significant fraction of new development is occurring on larger lots and is located outside existing or planned water and sewer service areas

Local communities are finding the need to develop rural cluster models to handle emerging patterns of new development. These trends are best exemplified in Maryland. A statewide land use survey indicated that large–lot development (1 du/ac or larger) was the fastest growing land use and comprised about 20% of all residential development in the last decade (MOP 1991). On an areal basis, large–lot development constituted over 76% of all land converted to residential use over the same period. Lastly, an astonishing 84% of all residential development (mostly large lot development) occurred outside of existing or planned water and sewer service areas.

While rural land use trends suggest that an enormous land area exists where clustering could be applied, these areas do present special problems with respect to waste disposal, water supply, drainage, roads and other concerns. Thus, existing cluster models must be adapted for rural areas where growth is increasing.

10. In general, communities feel that they are capable of reviewing and enforcing cluster requirements

A majority of communities surveyed by Heraty (1992) are confident that their plan review procedures for cluster development are effective. In many communities, cluster development proposals are subject to more formal and public review that can include a special exception process.

On the other hand, communities have less confidence in the ability of homeowner's associations to maintain open space, private roads or stormwater management facilities over the long–term, unless membership is mandatory and failure to pay annual dues results in a property lien (Arendt 1994). Other communities feel that a critical size is needed to create a successful homeowners' association, and therefore limit or discourage clustering on small development parcels.

Some Examples of Stream Protection Clusters

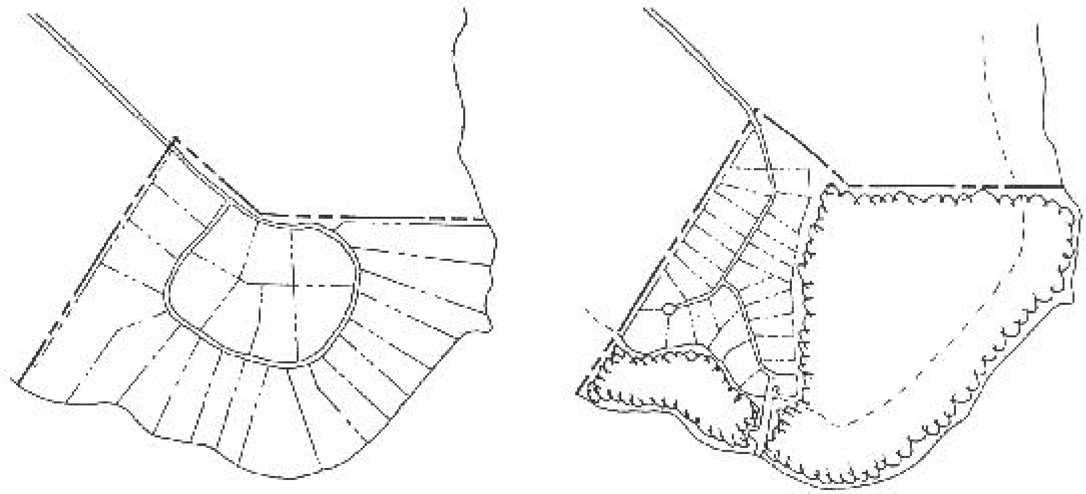
As noted earlier, no cluster program has been expressly designed with stream protection or impervious cover reduction in mind. The potential to achieve both goals, however, is clearly evident in some of the cluster layouts shown in Figures 18–20. The examples are chosen to illustrate the range of development situations where clustering has been effectively applied—infill developments, residential subdivisions, and rural homes.

Performance Criteria for Cluster Developments

Eight general performance criteria are recommended for the design of effective stream protection clusters. Each criteria is intended to be quite general in nature, to allow each locality to interpret and adapt them in the context of their residential zoning categories. The eight key performance criteria for clustering are:

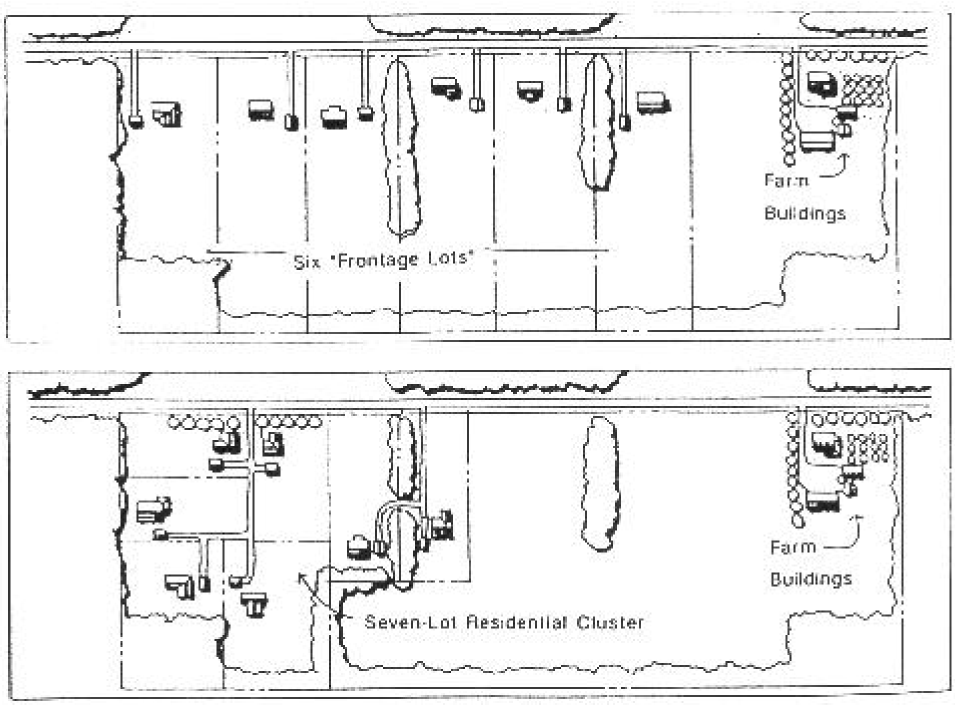
1. Design Objective
2. Minimum Requirements for Clustering
3. Computation of Net Site Density
4. Flexibility in Design Standards
5. Open Space Requirements
6. Green Space Requirements
7. Management Options
8. Rural Cluster Options

FIGURE 18: SCHEMATIC OF A RESIDENTIAL CLUSTER DEVELOPMENT (OHREL ET AL. 1995)



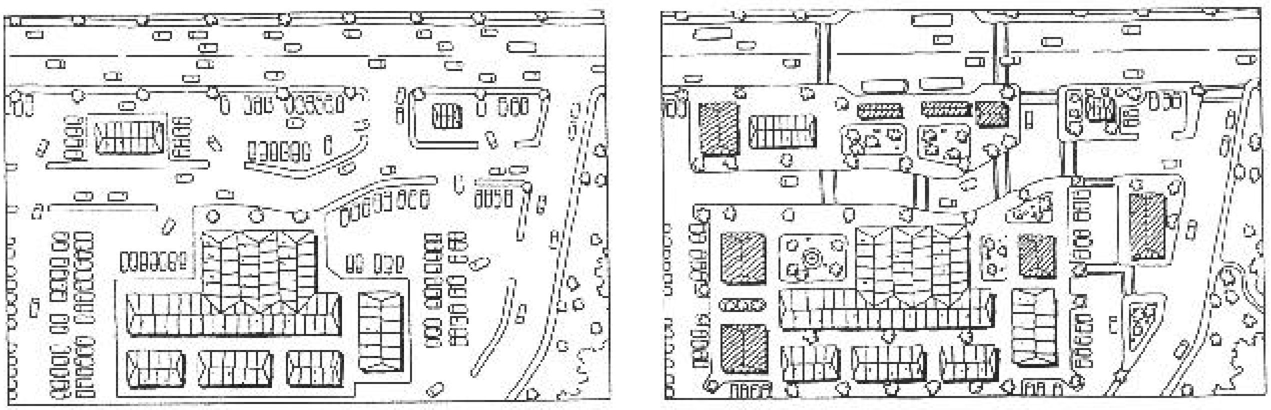
Clustering residential subdivision from 2 acre lots to half acre lots results in the preservation of open space along the waterfront. In this example, a shoreline buffer and community marina also protect the shoreline.

FIGURE 19: SCHEMATIC OF A RURAL CLUSTER DEVELOPMENT (ARENDT 1994)



Large and deep frontage lots are a common feature of many rural developments. Clustering units on smaller one acre lots preserves up to 80% of the parcel in open space.

FIGURE 20: SCHEMATIC OF AN INFILL CLUSTER DEVELOPMENT (SOURCE: WELLS 1994)



Criteria 1. Impervious Reduction and Green Space Preservation

The acid test for approval of a stream protection cluster proposal is that it will create measurably less impervious cover than the traditional development pattern it replaces. In addition, the cluster proposal must demonstrate that it fully reserves all existing resource protection areas and related buffers on the site in green space. To demonstrate that a cluster meets the impervious cover reduction test, a developer may be required to prepare a conventional subdivision layout for the site. The amount of impervious cover created under the two site layouts is then compared.

Often a quick comparison of the total road length created under the conventional and cluster layout can be used as a shortcut assessment.

Criteria 2. Minimum Requirements for Clustering

In general, cluster development is encouraged on most development parcels. Communities may, however, wish to restrict clustering to subdivision parcels five acres or larger in size, in order to support a viable use and meet open space requirements. In addition, some communities may restrict or condition cluster on very large parcels, to prevent the imposition of large scale development on small communities. The conditions may be as simple as requesting more detailed traffic studies to determine the impact on the local community. Most importantly, cluster should not be allowed if it results in the extension of water and sewer lines beyond the current approved "envelope" or requires the construction of a package plant for wastewater disposal. The premise is that stream protection cluster should never create additional water and sewer capacity that attracts more development than has already been planned.

A second key restriction relates to the minimum lot size that can be effectively clustered. Generally, dense residential zones that have more than six dwelling units per acre (i.e, one–sixth acre lots) cannot be easily clustered for a simple lack of space. The minimum density that can be clustered can be reduced somewhat if neo–traditional development patterns are employed that eliminate front yard setbacks and allows "zero lot lines" (i.e., homes are allowed to abut the property line).

A third key requirement is the formation of a legal entity to manage open space, usually known as a homeowner's association. Some of the minimal legal requirements for setting up an enforceable homeowner association are described in Hanke (1970), as well as in Criteria 7.

Criteria 3. Computation of Net Site Density

As noted earlier, communities can offer two possible stream protection cluster options, depending on how they define unbuildable land. Under the more generous Full Density Transfer (FDT) option, communities have a very conservative definition of what constitutes unbuildable lands. Only easements, right of ways and open water are recognized as "unbuildable." While development is also not permitted on any wetlands, steep slopes, floodplains and stream buffers present on the site, these areas are not subtracted from gross density. Thus, under the FDT model, a developer protects these areas within community green space, but can increase density elsewhere on the site to compensate for the lost density.

Under the more restrictive Partial Density Transfer (PDT) model, a community subtracts from gross zoned density for the site some or all of the land areas in the following categories:

- Existing Right of Ways and Easements
- Open Water
- Jurisdictional Wetlands
- Floodway or Floodplains
- Steep Slopes
- Stream Buffers
- Prime Woodlands
- Private Roads
- Shorelines

to arrive at the net density for the site. Thus, under the PDT model both the number of rooftops (dwelling units) and the road network are reduced. In addition, the site area that falls in the unbuildable category as defined above is not counted toward the required open space for the cluster development.

A general summary of performance criteria for the FDT and PDT models is provided in Table 17.

Table 17: Two options for Stream Protection Cluster for One Acre Lots

Performance Standard	Full Density Transfer Option (FDT)	Partial Density Transfer Option (PDT)
Minimum Site Size	5 acres	5 acres
Minimum Lot Size	10,000 sq. ft.	10,000 sq. ft.
Net Density	Equals Gross Density Less ROW's	Gross Density Less Unbuildable Land
Unbuildable Land	includes only permanent right of ways and easements, and open water	includes ROW, open water, *plus* wetlands, steep slope, floodplains, stream buffers and prime woodlands
Open Space Req.	50 to 80% of site area	33 to 50% of site area
Consolidation	75% of green space	75% of open space
Green Space	no less than 70% of open space	no less than 50% of open space
Community Space	no more than 30% of total open space	no more than 50% of total open space
Green Space Uses	Vegetative Target: predevelopment forest, with siting of stormwater BMPs, common OSDS, and nature trails where justifiable	
Community Space Uses	Limit Creation of Impervious Surfaces. Ballfields, playgrounds, pools, hard courts, bike trails, and stormwater ponds permitted. Vegetative Target: minimize extensive turf areas, and utilize native landscaping. Require design by registered LA.	

Criteria 4. Flexible subdivision design criteria

The heart of clustering are the provisions that allow designers to reduce the dimensions of individual lots within a residential zoning category. The key principle is *lot averaging*, whereby the net density for the site is expressed as an average over the entire parcel, rather than a fixed area per lot. An example of how lot dimensions can be reduced for one acre lot single family homes is shown in Table 18. As indicated, a community permits:

- individual lots to be as small as 10,000 square feet
- setbacks on the front, side and rear yards to be as short as 25 feet (in some cases, the setbacks are expressed as a minimum distance to adjacent homes rather than the property line).
- frontage requirements to be cut in half
- access roads narrowed to 20 to 26 feet
- sidewalks on only one side of streets (or eliminated altogether if alternative pedestrian access is provided)
- a small number of nonstandard or irregular lot shapes, such as flag lots

TABLE 18: COMPARISON OF SINGLE FAMILY HOME DIMENSIONS CONVENTIONAL VS. CLUSTER DEVELOPMENT/ONE ACRE LOTS

Site Factor	Detached SFR	Detached Cluster
Minimum Site Size	5 acres	10 acres
Maximum Site Density	1 dwelling unit/acre	1 du/acre average
Lot Size	40,000 sq. ft. min	10,000 sq. ft. min
Frontage	150 ft. min	75 ft. min
Front Yard	40 ft. min	25 ft. min
Side Yards	25 ft. min/ 60 ft total	10 ft. min/ 25 ft. total
Rear Yard	40 ft. min.	25 ft. min
Bldg. Footprint	5% of lot	18% of lot
Open Space Required	none	33% of site min.
Road Width	34 to 36 ft.	20 to 26 ft.

The exact reduction in lot dimensions depends on the base zone category that is being clustered (e.g., 6 du/ac, 4 du/ac, 2 du/ac, 1 du/ac, 0.5 du/ac etc.) As one might expect, flexibility in reducing lot dimensions sharply declines as the density of the base zone becomes more intense (e.g., 6 du/ac) compared to larger lots.

Although commercial and industrial clustering is less common, it can be achieved by allowing a builder to increase the allowable *floor area ratio* for the zone. This term refers to the cumulative floor area of each story of the development divided by the buildable area of the site. In simple terms, this form of clustering involves the construction of taller buildings to protect undeveloped open space. From a practical standpoint there is a limit to how far this clustering strategy can be used. Typically, construction costs often skyrocket once a building exceeds three stories in height as a result of elevator and fire safety requirements (Allen and Moffet 1992), making clustering a more prohibitive option.

Criteria 5. Open Space Requirements

In return for flexibility in lot dimensions, a designer must reserve a percentage of site in open space. The exact percentage of open space required depends on the underlying density of the residential zone and the density transfer model employed.

In the FDT option, 50 to 80% of total site area must be reserved as open space. The lower range applies to medium density residential development, while the upper range applies to large lot development (2 to 20 acre lots).

The open space requirement in the Partial Density Transfer (PDT) cluster option ranges from 33% for medium density residential up to 50% for large lot development. The lower open space requirements for the PDT option must be added to the land areas that are already considered unbuildable for environmental or physical reasons. Thus, on a hypothetical 100 acre large lot development, 50 acres of open space must be reserved, in addition to whatever acreage is reserved to protect wetlands, floodplains, steep slopes and buffers.

As a general rule, a designer must consolidate at least 75% of the open space into a single contiguous unit to prevent fragmentation. The one exception to this requirement is when required natural protection areas are widely scattered across the site and therefore cannot be consolidated together.

Criteria 6. Green Space and Community Space Requirements

The site designer must allocate a fixed percentage of open space to green space and community space (see Table 17). Green space is defined as any open space retained in an undisturbed vegetative condition (i.e., wetlands, forests, meadows, etc.), whereas community space refers to open space devoted to recreation, managed turf, stormwater/ wastewater treatment or other community uses.

Green space is a key feature of any stream protection cluster, as it retains key resource areas in a natural state by preventing any clearing and grading during development. The green space requirement is expressed as a percentage of the open space requirement. In the FDT option, green space should comprise no less than 70% of open space; whereas, in the PDT option the requirement is no less than 50%. Further, green space should be designed to contain or connect as many wetland, floodplain, steep slope, forest conservation, stream buffer or habitat features as possible into a single unit.

Some of the management restrictions in green space include:

- prohibition of clearing and grading
- no active recreational areas
- no managed turf
- sharp limits on the creation of impervious areas, except for trails
- pondscapes must be prepared for any stormwater ponds and wetlands, located in green space

A management plan should be incorporated into the homeowner's agreement (or conservation easement) for the green space that specifies how the area will be maintained, including provisions for mowing and long–term vegetation and wildlife management.

The remainder of open space is managed as community space, where most uses and activities are allowable, including ballfields, playgrounds, pools, turf, and stormwater ponds or lakes.

Criteria 7. Options for Cluster Management

Residents in stream protection clusters share common property, which entails a joint responsibility for management and upkeep of the property. The most common legal framework for handling this responsibility is the homeowners association (HOA). While a complete discussion of this topic is outside the scope of this guide, it is worth noting that effective HOA arrangements often include the following elements:

- mandatory membership
- placement of a property lien if HOA dues are unpaid
- clear designation of which maintenance responsibilities are vested with the local government and the HOA
- right of public inspection and emergency repair
- provisions for public access, if any
- vegetation management plan
- procedures for notifying and educating new homeowners
- enforcement provisions

If green space in a cluster has exceptional value, and a locality is willing to accept a future maintenance burden, it may be deeded to a local park system, or be donated as a conservation easement to a willing local land trust organization. Additional information on legal frameworks for managing open space are provided in MWCOG (1995).

Criteria 8. Rural Cluster Options

Clustering in rural areas is one of the most effective tools to reduce impervious cover in sensitive watersheds. Rural is defined here as any area located outside of the water and sewer envelope, and zoned for large lot development (ranging from 1 du/ac up to 20 du/ac). A summary of performance criteria for rural clusters is presented in Table 19. Some of the key differences involved in this form of cluster are a slightly greater minimum lot size (15,000 to 25,000 square feet) needed to provide room for an on–site septic system. Given the large lot size found in rural areas, it is not unusual to reserve up to 80% of the site as open space (Yaro et al. 1990). Depending on the rural character of the community, the open space can be managed by a homeowner association or be protected by conservation easement.

A common technique is to cluster four to six individual units in a “pod” separated by wide belts of green space from other pods. Pivo (1990) notes that this separation technique provides residents both the privacy and country setting that attracts them to rural areas. If the cluster pods are located in forested parcels, they should be designed to minimize the “footprint” of individual lots. Footprinting is a technique where up to 50% of pre–development forest cover is retained simply by restricting tree clearing only for access roads, building pads, a narrow setback and the minimum area for septic systems (MWCOG 1991). Thus, trees are preserved not only in common open space, but on

TABLE 19: CONSIDERATIONS FOR DESIGNING CLUSTER DEVELOPMENTS IN RURAL SITES

Site Planning Factor	Performance Criteria
Maximum Density	cluster development shall not be so dense as to require the extension of water/sewer lines to serve the units.
Minimum Lot Size	15,000-25,000 sq. ft. (to accomodate on-site sewage disposal)
Cluster Pods	utilize small cluster "pods" (5-6 du) separated by at least 200-300 ft. of open space from other pods
On-site Septic	a common septic field may be shared within a pod.
Footprinting	lot clearing restricted to building pad and 15 ft. setback from structure
Road Width	minimum roadwidth of 16 to 18 ft. for less than 10 du
Driveways	12 ft. wide shared driveways
Turnaround	hammerhead
Distance from Major Road	no homes directly fronting road
Open Space Requirement	up to 80% of site for large lots
Management of Common Space and Stormwater/Wastewater	open space managed through a perpetual conservation easement, shared stormwater and septic systems through enforceable maintenance agreement

individual lots. In a further effort to prevent runoff, lot grading should be done to maximize "runon"—directing rooftop runoff over pervious surfaces.

Rural cluster should also promote relaxed road and drainage requirements. These include narrow streets (16 to 18 ft) and driveways (12 ft), hammerhead turnarounds and open channel drainage (rather than curb and gutter). These techniques are intended to reduce the cost of roadbuilding for the developer. Roadbuilding costs have often discouraged the creative site layouts needed for rural cluster. Indeed, most rural development has historically been concentrated in strips along rural highways and county roads, where each large lot fronts the roadway and is served by its own long driveway. This development pattern wastes open space and creates needless impervious area (see Figure 20). Strip development can be eliminated by prohibiting individual lots from fronting on major roads.

Another possible element of a rural cluster is a common or shared septic system (OSDS) to dispose of wastewater. The benefit of a common OSDS system is that it allows a tighter cluster pattern and smaller minimum lot size. In recent years, significant advances have been made in the performance and reliability of these systems (for a good review, see Ohrel, 1995 and Chapter 13 in Arendt 1994). Still, maintenance of these systems may be problematic unless a rural cluster is managed by a competent homeowner's association.

Resources Needed for Implementation

Communities face two key hurdles when implementing an effective stream protection cluster program. The first hurdle is the review and modification of existing subdivision codes to identify opportunities for clustering within existing zoning categories, followed by the adoption of enabling ordinance or zoning amendment to formally permit it as a development option. The second, and equally difficult hurdle, involves developing a wide range of incentives to get the development community to widely implement the cluster option after it is adopted.

The time commitment to actually draft a stream protection cluster ordinance or zoning amendment is not great, and can usually be done with three months or less of staff time. Some general ideas to consider when drafting the ordinance or zoning amendment can be found in Table 20. More time, however, is usually needed to orchestrate the local

TABLE 20: CHECKLIST FOR AN EFFECTIVE LOCAL CLUSTER ORDINANCE

Application Procedure 9 required submittal information 9 traffic analysis 9 plan review schedule 9 public input/special hearing	Eligibility Requirements 9 minimum site size 9 location in community 9 adjacent uses
Open Space/Density Calculations 9 definition of unbuildable lands 9 density/intensity formula 9 impervious surface limits 9 mandatory open space req. 9 density credits (if any)	Flexible Lot Specifications For: 9 type of residential units 9 smaller minimum lot size 9 reduced frontage requirements 9 reduced front/back and side setbacks 9 height restrictions/bufferyards
Open Space Requirements 9 green space 9 consolidation 9 landscaping 9 allowed and restricted uses 9 common maintenance agreements	Criteria for Shared Facilities 9 narrower private streets 9 shared driveways 9 wastewater disposal 9 stormwater BMPs 9 separation of clustered units
Note: other guidance on constructing more effective local ordinances can be found in Table 32 and in Schueler (1994)	

consensus to actually adopt it (perhaps 6 to 18 months). The greatest consensus is achieved when the ordinance or zoning amendment is developed with the input of a diverse stakeholder team, consisting of builders, planners, landscape architects, lenders, land trusts, road and drainage engineers and consultants. Public meetings and other outreach activities are an indispensable aspect of the adoption process. After all, the goal is not merely to get a stream protection cluster ordinance or amendment adopted, but to gain wider acceptance of clustering as a cost–effective and marketable form of development within the building community.

Some of the strategies that can be used to promote wider acceptance of stream protection clusters include:

- additional design flexibility (drainage, sidewalks, roads, common facilities)
- appointment of cluster coordinator within the planning authority to streamline the design and approval process
- periodic outreach to designers and builders to educate them about the potential cost–savings of cluster
- active promotion of cluster "success stories"
- subwatershed or site limits on total impervious cover; and,
- in some cases, limited density bonuses (cf. Arendt 1994)

Communities should also recognize that a stream protection cluster program will probably result in a slightly greater demand on staff time to review the more complex development proposals involved in clusters, as well as training site designers on its creative use. Heraty's survey indicates that an average of about 18% more staff time is needed to review cluster development proposals, compared to conventional subdivision proposals.

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