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**An Ecological and Physical Investigation of Pittsburgh Hillside  
REPORT to the City of Pittsburgh Hillside Committee**

**Executive Summaries**

Final Report  
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## PREFACE TO EXECUTIVE SUMMARIES

This investigation of the ecological and physical environments of Pittsburgh's hillsides, with economic and legal support, is intended to assist the City of Pittsburgh Hillsides Committee with its deliberations and recommendations regarding the future of Pittsburgh's hillsides. While a number of opinions have been voiced about the regulation of hillside preservation, conservation or development, there has been little research on the character or function of the hillsides. One of the goals of this project has been to provide an informed framework for establishing coherent public policy.

The REPORT to the City of Pittsburgh Hillsides Committee is a compilation of four individual reports that together form that framework:

- Economic Report
- Ecological Report
- Physical Report
- Legal Report

Creating an appropriate policy toward hillsides involves an understanding of their many contributions to the viability of the city-functional, economic, form-giving, aesthetic, and social-as well as the liabilities they may impose on development-hazards and costs. This is a multi-disciplined challenge. The investigation brings together expertise in the environment, ecology, geology, urban design, and landscape architecture. Legal and economic expertise provides firm grounding to the investigation's recommendations.

All recommendations and evaluations documented in this REPORT are conceptual in nature and do not suggest engineering solutions. The REPORT is not intended to contain recommendations for specific private property or properties, and not text or illustrations should be interpreted as such.

The Executive Summaries that follow highlight the salient points and arguments of the respective reports. Please refer, though, to the full reports for additional and more detailed information.

Executive Summary  
Economics of Hillside Slope Development  
Stephen Farber, PhD

The economic values of hillsides and the preservation of vegetative covers on hillsides arise in several ways. First, the topographic relief provided by Pittsburgh hillsides is a major landscape defining feature that is distinctive and provides a unique identity to the Pittsburgh region. This value is manifest in the visual image of Pittsburgh projected nationally and internationally with scenes of the Golden Triangle and associated riverine/hillside landscapes. This value is inestimable as a distinctive feature, keeping the image of Pittsburgh in the public eye as a pleasant place to live and visit; an economic development value that would be difficult to quantify but is likely substantial. A second value of the unique topographic relief is its role in defining neighborhoods and communities. The hills and valleys afford a sense of place and community identity that is inestimable, yet clearly apparent from the settlement patterns and strong identities with local communities. A third value is a more estimable economic value; the economic value of the topographic and associated land cover landscape amenities. As noted below, these values are most often evidenced in enhanced property values in proximity to those amenities. Finally, a very important and estimable set of economic values of the land cover associated with the typical topographic relief in Pittsburgh is attributable to the natural system services of those ecosystems. These values are discussed below.

A considerable number of reputable economic studies illustrate the economic values of various urban environmental amenities. The most reliable of these studies estimate the enhanced property values attributable to those amenities. These studies have been undertaken in a variety of urban areas: Boulder, CO; Columbus, OH; Portland, OR; England; Baltimore, MD; Washington, DC; Fairfield, CT; Grand Rapids, MI; Los Angeles, CA. They all demonstrate that proximity to green spaces and/or open spaces enhances property values. These premiums for proximity can range up to 25% of the value of a property; but are most likely to augment property values by around 5%.

The vegetative cover typically accompanying hillsides defines ecological types that provide a variety of natural system services. Vegetative cover in watersheds reduces stream pollution, as shown by several studies. Reduced pollution has economic value in terms of increased recreational values, reductions in health related costs, and reductions in water treatment costs downstream. The ecological values of tree cover can be considerable; for example, in the management of runoff. A study of Los Angeles illustrates this: increased tree cover would reduce stormwater and flood control costs by nearly \$4 per tree. The pollution and heating/cooling values of tree cover were shown to be considerable in a Chicago study.

It would be reasonable to expect that public infrastructure (roads, sewers, water, electricity, etc.) would be considerably more costly in the case of hillside developments than development in flatter relief. Similarly, development in areas not served by this infrastructure would be more costly than in "infill" areas. For example, a study in Australia illustrates that road costs were \$2500 higher per dwelling unit in an undeveloped "Greenfield" than in an "Urban Infill" development.

Even when developers pay for the extraordinary infrastructure costs, and pass these costs on to buyers, there remain the public infrastructure maintenance costs, and public service costs (fire protection, police protection, waste collection, etc.). Impact fees are not typically assessed to cover these extraordinary recurring costs. To the extent that the full value of extraordinary costs of hillside development are not paid for, other taxpayers must end up subsidizing these developments, and the less-than-full-costs simply encourage such developments. Costs of public services for residential developments generally compare unfavorably with the tax revenues from those developments. A summary of over 90 cost of services studies in the US showed that, on average, residential developments cost roughly 15% more than the revenues that could be expected from those developments on a per dwelling unit basis (property taxes, local sales and income taxes, etc.)

In addition to extraordinary infrastructure and public service costs, hillside developments, and associated alterations of ecosystems, result in the loss of natural systems services, which may have considerable economic value, especially in landslide, flood prone, high topographic relief areas such as Pittsburgh. The public bears the costs of these lost services in the form of increased pollution of streams, increased water treatment costs, increased flood conveyance and control costs, etc. These increased costs have an equity implication when it is poorer people who live downhill or in downstream floodplains.



a tree in a forest can also be found in the value of the wood, when extracted, milled into lumber and brought to the mill workers shop where it can be cut and joined to create fine furniture. Trees in the forest provide jobs for the lumberjack that cuts the tree, the sawmill owner that processes it from tree trunk to usable lumber, the truck driver that hauls it, and the craftsman who makes wonderful objects from lumber. The tree as a raw material is a resource that supports life, enables the economy and is ultimately a renewable resource although one that regenerates slowly over time.

The intrinsic value of the tree is a more complicated question. Does a tree have a sense unto itself? Does it feel pleasure and pain? Does it act in its own self interest? Can humans act as advocates for the legal rights of tree's in much the same way that act as advocates for corporations, small babies, or other non-verbal entities? Recent philosophical literatures raises the question of agency and self interest, moral authority and advocacy are subjects of intense study and conflicting argument. Recent forays in the literature of political ecology examine the idea that nature and tree's could have rights, or that the divided houses of culture and nature could reunite in a new concept of scientifically and metaphysically informed government. Are these thoughts appropriate for a city like Pittsburgh, where the culture and economy has been constructed and sustained upon the ideology of resource use and the economies of extraction?

For our purposes we can leave behind the heady discussions of philosophy and instead discuss intrinsic value in terms of a tree's essential relationship to the land. We can also discuss the utilitarian services this tree provides to the human community during its tenure, which by the nature of the tree's self-replicating life-force can be quite substantial, The tree is part of a network of roots processing nutrients. The roots provide the structure that holds the soil from erosion. The tree has a role in the hydrologic cycle, processing water in the root zone, it draws water through the trunk and releases it from its leaves into the air in the form of gas. It has a role to play in air quality, it is a sink for carbon dioxide and a source of clean fresh air through the stomatal openings in the leaves. The structure of the tree provides shelter for wildlife, its fruits provide food, the shade cools the air. The tree when alive and part of a forest is a primary structural element of a larger ecological infrastructure that is all alive. A tree competes with other trees and plants in the forest for sunlight, Its bark reacts to nails and materials that pierce it, healing itself, not unlike our own flesh. It reacts to changes in the weather, it blooms in the spring, cloaks itself in colorful foliage each fall, and reveals its fundamental bare wood structure each winter. The tree is alive, it procreates, its value is unto itself and in relationship to the forest. Humans can share those values as members of the forest community, or impose a more utilitarian value upon the tree, and deny its life. Mans dominion over nature goes back to the Bible. Despite this history of dominion, the tree is a living entity that is part of the network of life. A living tree has a defensible role in the human economy based on the studies of the environmental economist Steve Farber, whether it has intrinsic value that can be imposed on others, is the meta-topic (but not the focus) of this study. The primary topic is utilitarian, steep wooded hillsides are green-infrastructure that bring significant services to human communities. Green infrastructure mitigates landslides, storm water impacts and air quality issues. Following the bias of Pennsylvania's courts, we will confine what by now should be a clearly perceived empathetic interest (on the part of this author) in the life of nature, to its subservient role in the support of public safety and as a "reasonable" alternative to land use development, on the basis of green-infrastructure values.

**Tools to inform the discussion of City hillside zoning.**

Our sense of the “nature, or ecology of this place” is colonized by the language of cultural spaces, and architectural design. This is a highly abstract ideology of enclosure, of private parcel ownership and municipal authority. Municipal zoning seeks to minimize the negative impact of private development. It is at its strongest when focused upon the protection of public health, safety, morals or the general welfare of the greater community. Despite a history of urban landscape theory that has roots in ancient city design, modern authority in the writings of Ian McHarg and contemporary validity in the discourse of landscape ecology, political ecology and restoration ecology - the issues of ecosystem services are primarily undermined or enabled by parcel by parcel regulation and decision making. We assembled a team of artists, natural scientists, an environmental planner, an urban designer and various computer mapping experts to develop tools that might enable natural systems in the city. The first question we struggled with was what component of the natural world could we target, that might -- provide the relevant argument that would allow the Hillside Committee of the City of Pittsburgh to feel confident that a new hillside zoning regulation was equitable to landowners as well as legal and enforceable? The second question we struggled with was what issues could we identify that would enable the most robust democratic discourse within each neighborhood, about the value of open space, and the struggle over the meaning of the public realm, the public will, and larger social and environmental ideals in relationship to the rights and aspirations of individual property owners?

After much consideration, we decided to provide analysis of both quantitative and empirical data that can inform rational decision making on steep slope properties at the level of zoning policy, regulation and enforcement. The focus in this section is upon 25% slopes or steeper, this is an angle at which many soils become unfit for urban development, creating both on site and downslope threats to public safety. This is also a slope angle where the buildings in the city drop off significantly, and city services in terms of roads and sewers are inconsistent and often nonexistent. In turn, this also means that these are the places in the city where remnant forests have flourished, or where natural recovery has occurred to significant effect, in some cases creating interconnected forest patch-corridor matrices that result in emerald arcs, forests that are visually stunning and increasingly valuable to humans that value proximity to nature and the green-infrastructure services of nature, even at the urban core.

All materials in the Ecological Report have been developed with the express intention of reflecting the analysis and outcomes of Cyril Fox’ study of the authority and jurisprudence of land-use controls. Following the Fox report, we were seeking an analytical methodology that would “identify potential danger from landslide and other development problems” as well as examine the cities current stock of “adequate public services and infrastructure” at each of these parcels. Finally we were seeking to minimize any “perception of arbitrary decision making” – through the rigorous application of accepted material data sets supported by the City of Pittsburgh, Allegheny County and the United States Agricultural Service. In the high ideals and ancient history of rational planning, we have decided that the best way to act in the interest of the public realm, was to let the data speak for itself.

**Specific goals:**

Tools for Democratic Discourse

- Contextual analysis at the watershed scale.
- Open space needs analysis at the neighborhood scale, and

Decision Tools

- Decisions analysis at the parcel scale.
- Field studies to inform land use guidelines.

**Tools for Democratic Discourse.**

- Contextual analysis at the watershed scale.

The ecological report focuses first on the watershed scale - maps that help us understand the urban relationship to topography, hydrology, woodlands, parks and interior forest. This is nothing more than a conceptual framework to help us understand the function and failure of natural ecosystems within the city. The final map in this series (map 1.7) gives us a sense of the significant forested areas of the city, and their relative interior forest, defined as the forest area approximately 100 meters from the edge of forest patch (Moyer 2003). Interior forest habitat is critical to maintaining populations of organisms which require stable sources of food and cover.

- Open space needs analysis at the neighborhood scale.

Secondly we looked at the city on the scale of neighborhoods. On a neighborhood by neighborhood basis, we mapped resident income, average value, population density and vacant parcels in relationship to parks and open space. In this section we argue that neighborhoods with low per capita income, low value, and high population density have a greater need for open spaces than those places with high income, high value and low population density. These maps provide the reader with a means to understand what neighborhoods have access to open space, to parks and forests and which do not. Arguably this can be used by citizens and officials alike to think about what these steep hillsides mean in terms of the social and ecological characteristics of each neighborhood, and where there are issues of equity and access or lack there of.

**Decision Tools**

- Decisions analysis at the parcel scale.

We were seeking to develop a decision matrix, that would allow each parcel in the city to be analyzed and then sorted into areas for preservation, conservation or development. We were seeking an analytical methodology that would allow us to identify potential danger from landslide as well as available public infrastructure that could service each parcel. Our method is based upon the best available knowledge of soils (in terms of erosion, foundation and roadbed safety) in the city. And upon each parcels relationship to adjacent buildings, or proximate (within 100-300 feet) roads and sewers. This is the most objective, rational manner that we could come up with to sort parcels into scientifically informed and legally defensible zoning categories. The data for this analysis is from the United States Agricultural Department Study of the Soils of Allegheny County, and existing City of Pittsburgh infrastructure studies. Based on this data and analysis we were able to arrive at the following standardized definitions.

**Preservation:** land deemed environmentally unfit for development due to erosive soils, and a lack of available City infrastructure.

**Conservation:** land with sensitive but not exclusionary soil characteristics for safe building practices, with some infrastructure necessary to support development.

**Development:** land with both the soil characteristics for safe building practices and available infrastructure to support development.

With the clear understanding that this exercise is intended to inform Pittsburgh City Zoning, we realized that the geo-referenced data sets would need to be effectively queried at the level of individual City parcels. We were able to develop a Microsoft Access database tool we call the “parcel identifier.” This tool allows the casual user, or City planner to query the infrastructure and soils databases for each City parcel using the lot and block numbers. The results of that query are recommendations for preservation, conservation or development described above. Finally we added two “push” categories that inform the user of potential threats to development due to the proximity of the underlying coal seam, or potential benefits to preservation and conservation ideals in terms of adjacent woodlands.

The relative effects of the “parcel -identifier” database are mapped and charted for the total number of parcels on slopes >25% in the outline below. This data set provides the committee with an understanding of the affects of the analysis on the total number of developable parcels. All four categories include the infrastructure and soil safety information. The ecology team would argue that the soils and infrastructure decision should remain unchanged, however there is room for discussion and decision on the “push” factors.

#### **Parcels Without Woodlands or Coal**

This is the cleanest and simplest presentation of the relationship between existing infrastructure and soil conditions as analyzed by the “parcel identifier.” Using just soils and infrastructure we have a very simple, clear and concise tool to inform decisions on zoning.

Preservation	3494 parcels (30%)
Conservation	3951 parcels (34%)
Development	4310 parcels (36%)

#### **Parcels with Coal Only**

If we were to only include the coal seam underlay as an additional -public safety- push factor, the categories increase or decrease by the following number of parcels/percentage:

Preservation	3806 parcels (33%)
Conservation	3937 parcels (33%)
Development	4012 parcels (34%)

#### **Parcels with Woodlands Only**

If we were to consider the parcel - woodlands condition as an additional -ecological systems- push factor the categories increase or decrease by the following number of parcels/percentage:

Preservation	5782 parcels (49%)
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Conservation 2897 parcels (25%)  
 Development 3076 parcels (26%)

**Parcels with Woodlands and Coal**

With the addition of both the woodland and coal “push” categories the categories either increase or decrease by the following number of parcels/percentage:

Preservation 5992 parcels (51% )  
 Conservation 2860 parcels (24%)  
 Development 2903 parcels (25%)

- Field studies to inform land use guidelines.

Given our industrial history, it is sometimes hard to fathom the import and value of the remnant and recovering forests of Allegheny County. The botanist found a high diversity of woody species within each of the sites and evidence of four typical forest community types in the three areas sampled. They identified 84 woody species in total: 66 of which were native (=79%), and 13 of which are native hardwood trees (15%) (See Table 1). Many trees were greater than two meters in circumference and one tree at exceeded three meters in circumference. The steep hillsides of Pittsburgh indeed sustain a diverse assemblage of tree species with their attending shrubs and understory trees. Four hardwood forest native plant communities were identified on the hillsides studied. (See Appendix A for complete descriptions of these forest types):

- \_\_\_\_\_ **Dry oak**– mixed hardwood forest, typically occurs on slopes with dry soil
- \_\_\_\_\_ **Red oak**– mixed hardwood forest, occurs in mesic soils and found on lower slopes in our survey
- \_\_\_\_\_ **Sugar maple**– basswood forest, often occurs on rich soils with rocky slopes and supports a rich vernal flora .
- \_\_\_\_\_ **Mixed mesophytic forest** - typically found on lower slopes, which is unique to the Southwestern portion of Pennsylvania, and supports an extremely rich and diverse flora.

The Geologist comments on the three major site areas, was cautionary. Site studies illustrate the importance of field checking maps of geological hazards and soil types as part of the final decision on the suitability of hillside land for development. Section 4.2 “Understanding the Soil Survey for Planning goes into more detail on this topic.

**In Conclusion**

Our studies illustrate the fact that there is available data upon which a hillside zoning plan can be written. Given the authority of the United State Department of Agriculture and the City of Pittsburgh, the soil data and infrastructure data are legally defensible sources applicable and indeed intended for land-use decision making. The field studies provide potent tools for informed land use guidelines, and a rational overview of the value of our remnant and recovering forests. The contextual analysis and open space analysis help us see the current patterns and baseline condition today. This report provides the committee with authoritative work on ecology, our colleague have provide equally thoughtful input on design, economy and law. We believe that we have had some success clarifying