How Much Value Does the City of San Diego Receive from its Park and Recreation System?

A Report by The Trust for Public Land's Center for City Park Excellence

For San Diego Department of Parks and Recreation, San Diego Foundation and Friends of Balboa Park

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THE TRUST *for* PUBLIC LAND

Executive Summary

The numerous parks and recreation programs of San Diego – from the neighborhood playgrounds to the vast natural reserves to the nationally known tourist magnets of Balboa and Mission Bay Parks – provide San Diegans with so many joys and benefits that many residents would not want to live in the city without them.

Although the system was not created specifically as an economic development tool, there is a gradually growing realization that the parks of San Diego are providing the city with hundreds of millions of dollars of value. This value, for the first time ever, has now been defined. Not every aspect of a park system can be quantified – for instance, the mental health value of a walk in the woods has not yet been documented and is not counted here; and there is no agreed-upon methodology for valuing the carbon sequestration value of a city park – but seven major factors are enumerated – *clean air, clean water, tourism, direct use, health, property value* and *community cohesion*. While the science of city park economics is in its infancy, the numbers reported here have been carefully considered and analyzed.

In 2007, two of the factors provided San Diego with direct income, either to the city's treasury or to its businesses. The first was increased property tax due to the increase in property value of certain residences due to their proximity to parks. This value came to $3.9 million in fiscal year 2007. The second is tax revenue from tourism spending by out-of-towners who came to San Diego primarily because of its parks. This value came to $8.6 million. Beyond the tax money, these factors also bolstered the collective wealth of San Diegans – by $2.6 billion in total property value and by just over $40 million from net income from tourists.

Three other factors provided San Diego residents with direct savings. By far the largest was via the human value of directly using the city's free parkland and recreation opportunities instead of having to purchase these items in the marketplace. This value came to more than $1.2 billion in 2007. Second was the health benefit – savings in medical costs – due to the beneficial aspects of exercise in the parks. This came to $45.1 million. And third was the community cohesion benefit of people banding together to save and improve their neighborhood parks. This "know-your-neighbor" social capital, while hard to tabulate, helps ward off all kinds of anti-social problems that would otherwise cost the city more in police, fire, prison, counseling and rehabilitation costs. This value came to almost $3.8 million in 2007.

The last two factors also provide savings, but of the environmental sort. The larger involves water pollution reduction – the fact that the trees, shrubs and soil of San Diego's parks retain rainfall and thus cut the cost of treating stormwater. This value came to $3.4 million in 2007. The other concerns air pollution – the fact that park trees and shrubs absorb and adsorb a variety of air pollutants. This value came to $5.9 million ($3.9 million for trees and $2 million for shrubs).

The park system of San Diego thus provided the city with revenue of $12.5 million, city government savings of $7.3 million, resident savings of almost $1.28 billion, and a collective increase of resident wealth of almost $2.7 billion in 2007.

Annual Value of the San Diego Park and Recreation System	
Summary	
Revenue Producing Factors for City Government	
Tax Receipts from Increased Property Value	**$3,922,000**
Tax Receipts from Increased Tourism Value	**$8,579,000**
Total, Revenue Producing Factors for City Government	***$12,501,000***
Cost Saving Factors to Citizens	
Direct Use Value	**$1,226,116,000**
Health Value	**$45,122,000**
Community Cohesion Value	**$3,795,000**
Total, Cost Saving Factors to Citizens	***$1,275,033,000***
Cost Saving Factors for City Government	
Stormwater Management Value	**$3,402,000**
Air Pollution Mitigation Value -- trees	**$3,909,000**
Air Pollution Mitigation Value -- shrubs	**$2,006,000**
Total, Cost Saving Factors for City Government	***$7,311,000***
Wealth Increasing Factors to Citizens	
Increased Property Value from Park Proximity	**$2,615,072,000**
Profit from Park-Related Tourism	**$40,033,000**
Total, Wealth Increasing Factors to Citizens	**$2,655,105,000**
Center for City Park Excellence, Trust for Public Land, April, 2008	

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Background

Cities are economic entities. They are made up of structures entwined with open space. Successful communities have a sufficient number of private homes and commercial and retail establishments to house their inhabitants and give them places to produce and consume goods. Cities also have public buildings – libraries, hospitals, arenas, city halls – for culture, health and public discourse. They have linear corridors – streets and sidewalks – for transportation. And they have a range of other public spaces – parks, plazas, trails, sometimes natural, sometimes almost fully paved – for recreation, health provision, tourism, sunlight, rainwater retention, air pollution removal, natural beauty, and views.

In successful cities the equation works. Private and public spaces animate each other with the sum greatly surpassing the parts. In unsuccessful communities, some aspect of the relationship is awry: production, retail or transportation may be inadequate; housing may be insufficient; or the public realm might be too small or too uninspiring.

Methodology

Based on our research, the Center believes that there are seven attributes of San Diego's park system that are measurable and that provide economic value to the city. What follows is a description of each attribute and an estimate of the specific economic value it provides.

1. Removal of Air Pollution by Vegetation

Air pollution is a significant and expensive urban problem, injuring health and damaging structures. The human cardiovascular and respiratory systems are affected with broad consequences for health-care costs and productivity. In addition, acid deposition, smog and ozone increase the need to clean and repair buildings and other costly infrastructure.

Trees and shrubs have the ability to remove air pollutants such as nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone and some particulate matter. Gases are absorbed by leaves, and particulates adhere to the plant surface, at least temporarily. Thus, vegetation in city parks plays a role in improving air quality, helping urban residents avoid costs associated with pollution.

In order to quantify the contribution of park vegetation to air quality, an air pollution calculator was designed to estimate pollution removal and value for urban trees. This program, which is based on the Urban Forest Effects (UFORE) model of the U.S. Forest Service (*see Attachment 1 for technical details*), is location-specific, taking into account the air pollution characteristics of a given city. (Thus, even if two cities have similar forest characteristics the park systems could nevertheless generate dissimilar results based on differences in ambient air quality.)

First, land cover information for all of a city's parks was obtained through analysis of aerial photography. (While every city has street trees and numerous other trees on private property, this study measures only the economic value of trees on public parkland.)

Based on the photographs, we calculated that there are 47,352 acres of parkland within the city limits of San Diego. This is broken down as follows: 39,441 acres owned by the city of San Diego, 2,496 acres owned by the county of San Diego, 1,814 acres owned by the state of California, 905 acres owned by the U.S. Fish and Wildlife Service, 812 acres owned by the Port of San Diego, and 144 acres owned by the National Park Service. (We were not able to ascertain the ownership of the remaining 1,740 acres, most of which appear to consist of surface water.)

Parkland in the City of San Diego **Acres By Agency Ownership**	
San Diego City	39,441
San Diego County	2,496
State of California	1,814
U.S. Fish & Wildlife Service	905
Port of San Diego	812
National Park Service	144
Other or Not Known	1,740
Total	47,352

Of 47,352 acres of parkland, 20.97 percent was found to be covered with trees. An additional 16.15 percent was found to be covered with shrubs.

San Diego Parkland **Percent by Type of Land Cover**	
Tree Canopy	20.97%
Shrub Canopy	16.15%
Other Pervious Surface	41.38%
Impervious Surface	15.70%
Water	5.80%
Total	100.00%

Because the calculator was designed to measure trees, it assumes a larger leaf area (technically referred to as an index of 6) than if it were measuring shrubs (an index of about 4). Thus, unlike in some other cities which have far lower concentrations of shrubs, each type of vegetation was calculated separately and the results were combined.

Then the pollutant flow through an area within a given time period (known as "pollutant flux") was calculated, taking into account the concentration of pollutants and the velocity of pollutant deposition. The resistance of the tree canopy to the air, the different behavior of different types of trees and other vegetation, and seasonal leaf variation are taken into account by the calculator.

The calculator uses hourly pollution concentration data from cities that was obtained from the U.S. EPA.[1] The total pollutant flux was multiplied by tree-canopy coverage to estimate total pollutant removal by trees in the study area. The monetary value of pollution removal by trees is estimated using the median U.S. externality values for each pollutant. (The externality value refers to the amount it would otherwise cost to prevent a unit of that pollutant from entering the atmosphere.) For instance, the externality value of preventing the emission of a short ton of carbon monoxide is $870; the externality value of the same amount of sulfur dioxide is $1500.

The result of the Air Quality Calculator for the park system of San Diego is an economic savings value of $5,915,000 -- $3,909,000 from trees and $2,006,000 from shrubs *(see Calculators 1A and 1B).*

2. Reducing the Cost of Managing Urban Stormwater

Stormwater runoff is a significant problem in urban areas. When rainwater flows off roads, sidewalks and other impervious surfaces, it carries pollutants with it. In some cases (such as younger cities like San Diego with systems which separate household sewage from street runoff) the rainwater flows directly into waterways and the ocean (or is directed towards detention basins and stormwater management features). In other cases (older cities with combined household and street systems), the rainwater runoff is treated along with household waste at a pollution control facility before going into a waterway. (However, if a storm is large, the great amount of runoff overwhelms the combined system and sewage flows untreated into rivers and bays.) Since San Diego's system is separated, human waste never becomes mixed with stormwater, even in big storms. However, much roadway detritus is still swept away and causes pollution that the Environmental Protection Agency plans to require treatment of in the future.

Parkland reduces stormwater management costs by capturing precipitation and/or slowing its runoff. Large pervious (absorbent) surface areas in parks allow precipitation to infiltrate and recharge the ground water. Also, vegetation in parks provides considerable surface area that intercepts and stores rainwater, allowing some to evaporate before it ever reaches the ground. Thus urban green spaces function like mini-storage reservoirs.

A model has been developed to estimate the value of retained stormwater runoff due to green space in the parks. (*See Attachment 2 for technical details.*) Inputs to the model consist of geographic location, climate region, surface permeability index, park size, land cover percentages, and types of vegetation. Because of numerous data challenges, the model has not been perfected yet and thus gives only a preliminary indication of value for the park system of the City of San Diego.

First, land cover data -- trees, open grassy areas, impervious surface, etc. -- was obtained through analysis of aerial photographs. This analysis reveals that the park system of San Diego is 78.5 percent pervious. The rest consists of impervious roadways, trails, parking areas,

[1] Data is from 1994. We are seeking funding to recalculate with more recent data.

buildings, hard courts, and also water surface. (While the model was developed with the sensitivity to distinguish between the different effects of such vegetation types as conifers and palms, the sensitivity of the aerial photographs was not great enough to make that kind of determination.)

San Diego Parkland Perviousness

Type of Cover	Acres	Percent
Pervious	37,171	78.5%
Impervious	7,433	15.7%
Water	2,749	5.8%
Total	47,352	100.0%

Source: Mapping Sustainability, 2007

Second, the same photographs were analyzed for the amount of perviousness of the *rest* of the City of San Diego – in other words, the city without its parkland. It was determined that San Diego (without its parks and not counting surface water) is 51.1 percent pervious. The pervious land consists primarily of residential front and backyards as well as private natural areas such as cemeteries, university quadrangles and corporate campuses.

Perviousness of the City of San Diego
(Not Counting Parkland or Water)

Total City Area (acres)	218,217	
Park Area	47,352	
Water Area	8,736	
Total Area without Parks or Water	**162,129**	
Type of Land Cover	**Acres**	**Percent of Total**
Total Pervious	82,896	51.1%
Total Impervious (streets, etc.)	79,233	48.9%

Source: Mapping Sustainability, 2007

Third, using U.S. weather data, the amount of rainfall (12.18 inches per year) and its characteristics (Mediterranean climate with precipitation confined to five winter months) were factored into the model. The model, which combines aspects of two other models developed by researchers with the Center for Urban Forest Research of the U.S. Forest Service, uses hourly annual precipitation data from each study city to estimate annual runoff. Then, the reduction in runoff is calculated by comparing the modeled runoff with the runoff that would leave a hypothetical site of the same size but with land cover that is typical of surrounding urban development (i.e., with streets, rooftops, parking lots, etc.). The result yields 406.3 million cubic feet of stormwater.

The final step in determining the economic value of a park system's contribution to clean water is calculating what it costs to manage stormwater using "hard infrastructure" (concrete pipes and holding tanks). This turns out to be a very difficult number to ascertain and is not known by the San Diego County Water Authority. The Department does report, however, that its annual budget for water treatment is approximately $28.6 million. Thus, by knowing the amount of rainfall the city receives it is possible to make an educated guess about the cost of treatment. This come out to be $0.008 (0.8 cents) per cubic foot.

Cost of Treating Stormwater in San Diego (per cubic foot)		
1	Rainfall per acre per year	44,213 cu. ft./acre
2	Acres of impervious surface	79,068 acres
3	Rainfall on impervious surface (line 1 * line 2)	3,495,861,609 cu. ft.
4	FY08 budget for water treatment	$28,579,000
	Cost per cubic foot (line 4/line 3)	**$0.008 cu. ft.**

By plugging these rainfall, parkland, imperviousness and treatment cost factors into the formula, an annual Park Stormwater Retention Value of <u>$3,402,000</u> is obtained for San Diego. *(See Calculator 2.)*

It should be noted that there is another possible methodology for determining stormwater savings due to parkland. Instead of looking at annual rainfall and the annual operating costs for the system, we could look at the one-time capital costs associated with constructing the system to handle single large storms. This may be more relevant considering that the U.S. Environmental Protection Agency is tightening its regulations and requiring more construction for clean water. A rough estimate may put this cost as high as $500 million (which would then be amortized over a 30-year period). We are presently analyzing this different approach, but these results will not be available until the end of 2008.

3. Hedonic (Property) Value

More than 30 studies have shown that parks and open space have a positive impact on nearby residential property values. (*See Attachment 3 for technical details.*) Other things being equal, most people are willing to pay more for a home close to a nice park. Economists call this phenomenon "hedonic value." (Hedonic value also comes into play with other amenities such as schools, libraries, police stations and transit stops. Theoretically, commercial office space also exhibits the hedonic principle; unfortunately, no study has yet been carried out to quantify it.) The property value of a park, incidentally, is separate from its direct use value; property value goes up even if the resident never goes into the park.

Property value is affected primarily by two factors: distance from the park and the quality of the park itself. It has been found that proximate value ("nearby-ness") can be measured up to 2,000 feet from a large park. Most of the value, however – whether the park is large or small – is within the first 500 feet, and in the interest of being conservative we have limited our valuation to this distance. It has also been found that people's desire to live near a park depends on characteristics of the park. Beautiful natural resource parks with great trees, trails, meadows and gardens are markedly valuable. Other parks with excellent recreational facilities are also desirable (although sometimes the greatest property value is a block or two from the park rather than directly adjoining it, depending on issues of noise, lights and parking). However, less attractive or poorly maintained parks are only marginally valuable. And parks with dangerous or frightening aspects can reduce nearby property values.

Determining an accurate park-by-park, house-by-house property value for a city is technically feasible but it is prohibitively time-consuming and costly. It is thus necessary to make an extrapolation from previous studies, plugging average historic national property values into the specific housing and park situation of the city under study. But this has a problem, too. Although sales data is available, only a small percentage of dwellings is sold in any given year. In order to be comprehensive we must rely on assessment data. But assessments, unlike sales prices, focus on items like bedrooms, bathrooms, structure age and size but ignore the value generated by nearby amenities. Also, assessments in San Diego are extremely variable and widely diverge from sales prices. Thus an extrapolative methodology was formulated to arrive at a reasonable estimate.

Using computerized mapping technology known as GIS, all residential properties within 500 feet of every significant park and recreation area in San Diego were identified. ("Significant" was defined as one acre or more; "park" included every park in the city, even if owned by a county, state, federal or other agency.) According to records of the Board of Revision of Taxes, there are about 491,000 residential properties (dwelling units) in the city of San Diego. Using GIS, we determined that there are 111,000 dwelling units within 500 feet of the park and recreation land in the city. And these dwelling units had a combined assessed value of $36,823,353,788.

Unfortunately, because of data and methodology problems, it has not been possible thus far to determine which of San Diego's parks are "strongly positive," "slightly positive" and "negative" – i.e., adding significant value, slight value or subtracting value to surrounding residences. We are continuing this line of research, but thus far -- despite interviews with park professionals, park users, realtors, assessors and after extensive analysis of crime data – we have not been able to make justifiable, replicable judgments on park quality. While new methodologies are being tested, we have chosen to assign the conservative value of 5 percent as the amount that parkland adds to the assessed value of all dwellings within 500 feet of parks. (This number is an average of the high, medium and low values of 15 percent, 5 percent and negative 5 percent that will be used when park quality can be established.) The result for 2007 was $1.841 billion in value due to park proximity.

We then used the residential property tax rate to determine how much extra tax revenue was raised by the city of San Diego based on the extra property value due to parks. Using a millage rate of $2.13 per $1,000 in assessed value, the result of the Property Value Calculator for the city of San Diego is <u>$3,922,000</u>. *(see Calculator 3.)*

Incidentally, we also performed an additional calculation. Because of Proposition 13, assessments in San Diego are unrealistic in comparison with actual sales prices. According to one study,[2] the average the assessment rate of a San Diego home may be only 70 percent of the sales price. In other words, on average the sales price is 1.42 times the assessed value.

Normalizing Assessments in San Diego *(Theoretical)*			
Assessed Value of all Residential Properties within 500 Feet of a Park	**Average Factor by which San Diego Properties are Under-Assessed**	**Theoretical "True" Value of all Residential Properties within 500 Feet of a Park**	**Portion of Value Due to Park Proximity Effect (5%)**
$36,832,000,000	142%	$52,301,440,000	**$2,615,072,000**

Normalizing the citywide assessment by 142 percent would have brought the market value to just over $52 billion in 2006. The portion of that value due to the park proximity effect – 5 percent – was $2.6 billion in 2006. This is the amount that parks added to the aggregate "property wealth" of San Diegans.

[Note: It is worth emphasizing that this property estimate is conservative for three reasons. First, it does not include the effects of small parks (under an acre) although it is known that even minor green spaces have a property effect. Second, it leaves out all the property value of dwellings located between 500 feet and 2,000 feet from a park. Third, it does not include the potentially very significant property value for commercial offices located near downtown parks.]

4. Direct Use Value

While city parks provide a great deal of indirect value, they also provide more tangible value through such activities as team sports, bicycling, skateboarding, walking, picnicking, bench-sitting and visiting a flower garden. Economists call these activities "direct uses." (*See Attachment 4 for technical details.*)

Most direct uses in city parks are free of charge, but economists can still calculate value by determining the consumer's "willingness to pay" for the recreation experience in the private marketplace. In other words, if parks were not available in San Diego, how much would the resident (or "consumer") pay for similar experiences in commercial facilities or venues? Thus, rather than income, the direct use value represents the amount of money residents save by not having to pay market rates to indulge in the many park activities they enjoy.

The model used to quantify the benefits received by direct users is based on the "Unit Day Value" method as documented in Water Resources Council recreation valuation procedures by the U.S. Army Corps of Engineers. The Unit Day Value model counts park visits by specific

[2] "Proposition 13 in Recession and Recovery," by Steven M. Sheffrin and Terri Sexton, Public Policy Institute of California, San Francisco, Calif., 1998.

activity, with each activity assigned a dollar value. For example, playing in a playground is worth $3.50 each time to each user. Running, walking or rollerblading on a park trail is worth $4.00, as is playing a game of tennis on a city court. For activities for which a fee is charged, like golf or ice skating, only the "extra value" (if any) is assigned; i.e., if a round of golf costs $20 on a public course and $80 on a private course, the direct use value of the public course would be $60. Under the theory that the second and third repetitions of a park use in a given period are slightly less valuable than the first use (i.e., the value to a child of visiting a playground the seventh time in a week is somewhat lower than the first), we further modified this model by building in an estimated sliding scale of diminishing returns for heavy park users. Thus, for example, playground value diminished from $3.50 for the first time to $1.93 for the seventh time in a week. Finally, for the few activities where a fee is charged – such as golf, ice skating and the use of fields for team sports – we subtracted the per-person fee from the imputed value.

The number of park visits and the activities engaged in were determined via a telephone survey of residents (with an accuracy level of plus or minus 4 percent). Residents were asked to answer for themselves; for those adults with children under the age of 18, a representative proportion were also asked to respond for one of their children. (Non-residents were not counted in this calculation; the value to the city of non-resident uses of parks is measured by the income to local residents from what these visitors spend on their trips. This is covered under income from out of town visitor spending.)

The result of the Direct Use Calculator for San Diego for the year 2007 is $1,226,116,000. *(See Calculator 4.)*

While it can be claimed that this very large number is not as "real" as the numbers for tax or tourism revenue, it nevertheless has true meaning. Certainly, not all these park activities might take place if they had to be purchased. On the other hand, San Diegans truly are getting pleasure and satisfaction – all $1.5 billion worth – from their use of the parks. If they had to pay and if they consequently reduced some of this use, they would be materially "poorer" from not doing some of the things they enjoy.

5. Helping to Promote Human Health

Several studies have documented the large economic burden related to physical inactivity. (*See Attachment 5 for technical details.*) Lack of exercise is shown to contribute to obesity and its many effects, and experts call for a more active lifestyle. Recent research suggests that access to parks can help people increase their level of physical activity. The Parks Health Benefits Calculator measures the collective economic savings realized by city residents because of their use of parks for exercise.

The calculator was created by identifying the common types of medical problems that are inversely related to physical activity, such as heart disease and diabetes. Based on studies that have been carried out in seven different states, a value of $250 was assigned as the cost difference between those who exercise regularly and those who don't. For persons over the age of 65 that value was doubled to $500 because seniors typically incur two or more times the medical care costs of younger adults.

The key data input for determining medical cost savings are the number of park users who are indulging in a sufficient amount of physical activity to make a difference. This is defined as "at least 30 minutes of moderate to vigorous activity at least three days per week." To determine this, we conducted telephone park use surveys of activities and of their frequency, dividing respondents by age. This telephone survey was, in fact, the same as the one carried out for direct use data (above) and had an accuracy rate of plus or minus four percent. In order to modify the results to serve the health benefits study, low-heart rate uses such as picnicking, sitting, strolling and bird watching were eliminated. Also, all respondents who engaged in strenuous activities less than three times per week were dropped. Based on the survey and the computations, we found that about 178,000 San Diegans engage actively enough in parks to improve their health – about 166,000 of them being under the age of 65, about 12,000 of them above 65. The calculator makes one final computation, applying a multiplier to reflect the differences in medical care costs between State of California and the U.S. as a whole.

The health savings due to park use for the residents of San Diego for the year 2007 is $45,122,000. *(See Calculator 5.)*

6. Income from Out-of-Town Park Visitor Spending (Tourists)

The amenities that encourage out-of-towners to visit a city include such features as cultural facilities, heritage places, arenas and parks as well as special events that take place there, like festivals and sports contests. Though not always recognized, parks play a major role in San Diego's tourism economy. *(See Attachment 6 for technical details.)*

To know the contribution of parks to the tourism economy requires knowledge of tourists' activities, the number of park visitors and their spending. Unfortunately, there is a severe shortage of data on park visitation and on the place of origin of park visitors. (By definition, local users are not tourists – any spending they do at or near the park is money not spent locally somewhere else, such as in their immediate neighborhood.)

The San Diego Park and Recreation Department does not have information on out-of-town visitor activity and spending. We thus sought visitation numbers and expenditures from other sources and then made educated guesses as to the percentage of trips that are entirely or substantially due to parks or a park. Based on data from the San Diego Convention and Visitors Bureau (CVB), the California Travel and Tourism Commission, and a recent telephone survey by the Morey Group, we calculated that 20 percent of tourists visited a park while in San Diego. We also calculated that 26 percent of San Diego park visitors came *because* of the parks, which are also the sites of museums and monuments. (Using this conservative methodology assures that we did not count the many tourists who came to San Diego for other reasons and happened to visit a park without planning to.) We thus estimated that just under 5 percent of San Diego tourism is due to the city's parks – 835,000 overnighters and 522,000 day visitors.

Knowing the average daily spending level of those tourists -- $107 per overnight visitor and $48 per day visitor -- we determined that total park-derived tourist spending came to $114.3 million. With an average tax rate on all tourist expenditures of approximately 7.5 percent[3], tax revenue to the city from park-based tourism is $8,579,000. In addition, since 35 percent of every tourist dollar is considered "profit" to the local economy (the rest is the pass-through cost of doing business), the citizenry's collective increase in wealth from park-based tourism is $40,033,000. *(See Calculator 6.)*

7. Stimulating Community Cohesion

Numerous studies have shown that the more webs of human relationships a neighborhood has, the stronger, safer and more successful it is. Any institution that promotes relationship-building – whether a religious institution, a club, a political campaign, a co-op, a school – adds value to a neighborhood and, by extension, to the whole city. *(See Attachment 7 for technical details.)*

This human web, for which the term "social capital" was coined by Jane Jacobs, is strengthened in some communities by parks. From playgrounds to sports fields to park benches to chessboards to swimming pools to ice skating rinks to flower gardens, parks offer opportunities for people of all ages to communicate, compete, interact, learn and grow. Perhaps more significantly, the acts of improving, renewing or even saving a park can build extraordinary levels of social capital in a neighborhood that may well be suffering from fear and alienation partially due to the lack of safe public spaces.

While the economic value of social capital cannot be measured directly, it is possible to tally up a crude proxy – the amount of time and money that residents donate to their parks. San Diego has thousands of park volunteers who do everything from picking up trash and pulling weeds to planting flowers, raising playgrounds, teaching about the environment, educating public officials and contributing dollars to the cause.

To arrive at the proxy number, all the financial contributions made to park foundations, conservancies and "friends of parks" organizations in a city were tallied. Also added up were all the hours of volunteer time donated to park organizations; the hours were then multiplied by the value assigned to volunteerism in 2006 -- $18.77 – by the organization Independent Sector.

The result of the Social Capital Calculator for the city of San Diego for 2007 is $3,795,000 *(see Calculator 7).*

[3] This averages taxes paid by overnight visitors who stay in hotels with day-trippers who do not. The full sales and transient tax rate is higher than 7.5%, but this is the portion that goes to the city of San Diego rather than to other jurisdictions such as the state of California.

Conclusion

While reams of urban research have been carried out on the economics of housing, manufacturing, retail, and even the arts, there has been until now no comprehensive study of the worth of a city's park system. The Trust for Public Land (TPL) believes that answering this question – "How much value does an excellent city park system bring to a city?" – can be profoundly helpful to all the nation's urban areas. For the first time parks can be assigned the kind of numerical underpinning long associated with transportation, trade, housing and other sectors. Urban analysts will be able to obtain a major piece of missing information about how cities work and how parks fit into the equation. Housing proponents and other urban constituencies will potentially be able to find a new ally in city park advocates. And mayors, city councils, and chambers of commerce may uncover the solid, numerical motivation to strategically acquire parkland in balance with community development projects.

Nowhere is this information more needed than in San Diego in 2008 as this great American city, with one of the country's most extensive park systems, strives to recommit itself as an outstanding 21st century metropolis.

Determining the economic value of a city park system is a science still in its infancy. Much more research and analysis must be undertaken. But this study, one of the first of its kind ever to be published, is offered as a mechanism to begin a great conversation about the present and future role of parks within the life – and economy – of San Diego.

Appendix 1

The following individuals were extraordinarily helpful in finding and providing data and analysis for the City of San Diego. We thank them for their assistance.

Renee Bahl, County of San Diego Parks & Recreation
Ginny Barnes, Chair of Parks & Recreation Board
Belinda Bencomo, Parks & Recreation
Bill Boston, State Parks
Ann Carter, Police Department
Darlene Davis, Chair, Balboa Park Committee and member, Parks & Recreation Board
Mauro Garcia, Deputy Director Developed Regional Parks
Tom Goad, Friends of Balboa Park
Lucy Hernandez, Volunteer Coordinator
Mike Kelly, Committee of 100
Irina Kumitz, Financial Management
Heidi Lang, Parks & Recreation
David Lang, Balboa Park Cultural Partnership
Dorothy Leonard, Mission Trails Regional Park CAC
Dave Long, Support Services
Debbie Marcotte, Special Events, Balboa Park
Ted Martinez, Jr., Director of Neighborhood Services
Stacey LoMedico, Director of Parks & Recreation
Paul Meyer, San Diego Foundation
Karen Miner, California State Parks
Betty Peabody, Friends of Balboa Park
Trent Robertson, Principal Drafting Aid (GIS)
True Ryndes, Friends of Balboa Park
Deborah Sharpe, Park Planning & Development
Paul Sirois, former District Manager, Balboa Parks
Gary Stromberg, Deputy Director of Community Parks
Tracy Walker, Senior Park Ranger, Mission Trails
Daniel Weinberg, Major Gifts and Philanthropy Planning
Carol Wood, Grants Administrator
Carolyn Wormser, Program Manager, Special Events

Appendix 2

The following individuals took part in the Colloquium, "How Much Value Does a Park System Bring to a City," in October, 2003.

Susan	**Baird**	Denver Dept of Parks & Recreation	Denver	Colo.
Kathy	**Blaha**	Trust for Public Land	Washington	D.C.
Blaine	**Bonham**	Pennsylvania Horticultural Society	Philadelphia	Pa.
Glenn	**Brill**	Ernst & Young	New York	N.Y.
Valerie	**Burns**	Boston Natural Areas Network	Boston	Mass.
Patrice	**Carroll**	Philadelphia Managing Director's Office	Philadelphia	Pa.
Donald	**Colvin**	Indianapolis Dept of Parks and Recreation	Indianapolis	Ind.
Ernest	**Cook**	Trust for Public Land	Boston	Mass.
John	**Crompton**	Texas A&M University	College Station	Tex.
Dick	**Dadey**	City Parks Alliance	New York	N.Y.
Nancy	**Goldenberg**	Philadelphia Center City Partners	Philadelphia	Pa.
Peter	**Harnik**	Trust for Public Land	Washington	D.C.
Nancy	**Kafka**	Trust for Public Land	Boston	Mass.
Alastair	**McFarlane**	U.S. Dept of Housing & Urban Development	Washington	D.C.
Ken	**Meter**	Crossroads Resource Center	Minneapolis	Minn.
Sarah	**Nicholls**	Michigan State University	E. Lansing	Mich.
Joan	**Reilly**	Pennsylvania Horticultural Society	Philadelphia	Pa.
Dan	**Stynes**	Michigan State University	E. Lansing	Mich.
Patrice	**Todisco**	Boston GreenSpace Alliance	Boston	Mass.
Susan	**Wachter**	University of Pennsylvania	Philadelphia	Pa.
Guijing	**Wang**	Centers for Disease Control	Atlanta	Ga.
Richard	**Weisskoff**	Everglades Economics Group	N. Miami	Fla.
Wayne	**Weston**	Mecklenburg Parks and Recreation Dept.	Charlotte	N.C.
Jennifer	**Wolch**	University of Southern California	Los Angeles	Calif.
Kathleen	**Wolf**	University of Washington	Seattle	Wash.
Matt	**Zieper**	Trust for Public Land	Boston	Mass.

Appendix 3

Resources Related to the Economic Value of Parks

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Attachment 1

Methods for Air Pollution Model

Methods and analyses conducted for this program are based on the Urban Forest Effects (UFORE) model developed by Nowak and Crane (2000). For each city, the pollutant flux (F; in g m^{-2} s^{-1}) is calculated as the product of the deposition velocity (V_d; in m s^{-1}) and the pollutant concentration (C; in g m^{-3}):

$$F = V_d \cdot C$$

Deposition velocity is calculated as the inverse of the sum of the aerodynamic (R_a), quasi-laminar boundary layer (R_b) and canopy (R_c) resistances (Baldocchi et al. 1987):

$$V_d = (R_a + R_b + R_c)^{-1}$$

Hourly meteorological data from local airports were used in estimating R_a and R_b. The aerodynamic resistance is calculated as (Killus et al. 1984):

$$R_a = u(z) \cdot u_*^{-2}$$

where u(z) is the mean wind speed at height z (m s^{-1}) and u_* is the friction velocity (m s^{-1}).

$$u_* = (k \cdot u(z-d))[\ln((z-d) \cdot z_o^{-1}) - \psi_M((z-d) \cdot L^{-1}) + \psi_M(z_o \cdot L^{-1})]^{-1}$$

where k = von Karman constant, d = displacement height (m), z_o = roughness length (m),

ψ_M = stability function for momentum, and L = Monin-Obuhkov stability length. L was estimated by classifying hourly local meteorological data into stability classes using Turner classes (Panofsky and Dutton 1984) and then estimating L^{-1} as a function of stability class and z_o (Zannetti 1990). When L < 0 (unstable) (van Ulden and Holtslag 1985):

$$\psi_M = 2\ln[0.5(1+X)] + \ln[0.5(1+X^2)] - 2\tan^{-1}(X) + 0.5\pi$$

where X = $(1 - 28\, z\, L^{-1})^{0.25}$ (Dyer and Bradley 1982). When L > 0 (stable conditions):

$$u_* = C_{DN} \cdot u\{0.5 + 0.5[1 - (2u_o / C_{DN}^{\frac{1}{2}} \cdot u))^2]^{\frac{1}{2}}\}$$

where C_{DN} = k $(\ln(z/z_o))^{-1}$; $u_o^2 = (4.7\, z\, g\, \theta_*)\, T^{-1}$; g = 9.81 m s^{-2}; $\theta_* = 0.09\,(1 - 0.5\, N^2)$; T = air temperature (K°); and N = fraction of opaque cloud cover (Venkatram 1980; EPA

1995). Under stable conditions, u_* was calculated by scaling actual wind speed with a calculated minimum wind speed based on methods given in EPA (1995).

The quasi-laminar boundary-layer resistance was estimated as (Pederson et al. 1995):

$$R_b = 2(Sc)^{\frac{2}{3}}(\mathrm{Pr})^{-\frac{2}{3}}(k \cdot u_*)^{-1}$$

where k = von Karman constant, Sc = Schmidt number, and Pr is the Prandtl number.

In-leaf, hourly tree canopy resistances for O_3, SO_2, and NO_2 were calculated based on a modified hybrid of big-leaf and multilayer canopy deposition models (Baldocchi et al. 1987; Baldocchi 1988). Canopy resistance (R_c) has three components: stomatal resistance (r_s), mesophyll resistance (r_m), and cuticular resistance (r_t), such that:

$$1/R_c = 1/(r_s + r_m) + 1/r_t$$

Mesophyll resistance was set to zero s m^{-1} for SO_2 (Wesely 1989) and 10 s m^{-1} for O_3 (Hosker and Lindberg 1982). Mesophyll resistance was set to 100 s m^{-1} for NO_2 to account for the difference between transport of water and NO_2 in the leaf interior, and to bring the computed deposition velocities in the range typically exhibited for NO_2 (Lovett 1994). Base cuticular resistances were set at 8,000 m s^{-1} for SO_2, 10,000 m s^{-1} for O_3, and 20,000 m s^{-1} for NO_2 to account for the typical variation in r_t exhibited among the pollutants (Lovett 1994).

Hourly inputs to calculate canopy resistance are photosynthetic active radiation (PAR; µE m^{-2} s^{-1}), air temperature (K°), wind speed (m s^{-1}), u_* (m s^{-1}), CO_2 concentration (set to 360 ppm), and absolute humidity (kg m^{-3}). Air temperature, wind speed, u_*, and absolute humidity are measured directly, or calculated, from measured hourly NCDC (National Climatic Data Center) meteorological data. Total solar radiation is calculated based on the METSTAT model with inputs from the NCDC data set (Maxwell 1994). PAR is calculated as 46 percent of total solar radiation input (Monteith and Unsworth 1990).

As CO and removal of particulate matter by vegetation are not directly related to transpiration, R_c for CO was set to a constant for in-leaf season (50,000 s m^{-1}) and leaf-off season (1,000,000 s m^{-1}) based on data from Bidwell and Fraser (1972). For particles, the median deposition velocity from the literature (Lovett 1994) was 0.0128 m s^{-1} for the in-leaf season. Base particle V_d was set to 0.064 based on a LAI of 6 and a 50-percent resuspension rate of particles back to the atmosphere (Zinke 1967). The base V_d was adjusted according to in-leaf vs. leaf-off season parameters.

Each city was assumed to have a tree/shrub leaf area index within the canopy covered area of 6 and to be 10% evergreen (Nowak, 1994). Regional leaf-on and leaf-off dates were used to account for seasonal leaf area variation. Particle collection and gaseous deposition on deciduous trees in winter assumed a surface-area index for bark of 1.7 (m^2 of bark per m^2 of ground surface covered by the tree crown) (Whittaker and Woodwell

1967). To limit deposition estimates to periods of dry deposition, deposition velocities were set to zero during periods of precipitation.
Hourly pollution concentration data (1994) from each city were obtained from the U.S. Environmental Protection Agency (EPA). Hourly ppm values were converted to µg m^{-3} based on measured atmospheric temperature and pressure (Seinfeld 1986). Missing hourly meteorological or pollution-concentration data are estimated using the monthly average for the specific hour. In some locations, an entire month of pollution-concentration data may be missing and are estimated based on interpolations from existing data. For example, O_3 concentrations may not be measured during winter months and existing O_3 concentration data are extrapolated to missing months based on the average national O_3 concentration monthly pattern. For some cities local pollution data were not available for some pollutants, so data from other regional monitors were used [Table 1].

Total pollutant flux (g m^{-2} of tree canopy coverage per year) is multiplied by tree-canopy coverage (m^2) (supplied by the model user) to estimate total pollutant removal by trees in the study area. The monetary value of pollution removal by trees is estimated using the median externality values for the United States for each pollutant. These values, in dollars per metric ton (t) are: NO_2 = \$6,752 t^{-1}, PM10 = \$4,508 t^{-1}, SO_2 = \$1,653 t^{-1}, and CO = \$959 t^{-1} (Murray et al. 1994). Externality values for O_3 were set to equal the value for NO_2.

Table 1. Location and Type of Surrogate Monitors Used for Cities with Missing Pollution Monitors

City Name	*Surrogate Monitor*	*Pollutants*
Albany, NY	Buffalo, NY	NO2
Albuquerque, NM	El Paso, NM	SO2
Chico, CA	Sacramento, CA	SO2
Columbus, OH	Cincinnati, OH	SO2
Fresno, CA	San Diego	SO2
Omaha, NE	Kansas City, MO	NO2
Pasadena, CA	Los Angeles, CA	O3, PM10, SO2
Santa Maria, CA	San Jose, CA	CO, NO2, SO2
Seattle, WA	Portland, OR	NO2
South Lake Tahoe, CA	Sacramento, CA	SO2
Visalia, CA	Fresno, CA	SO2

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Attachment 2

Technical description of the Storm Runoff Reduction Model

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INTRODUCTION

This model is based on research that led to development of two models: the Small Watersheds Model TR55 (United States Dept. of Agriculture, 1986) and the Single Tree Rainfall Interception Model (Xiao et al., 1998; Xiao et al., 2000a). Parks alter surface runoff because of their effects on land cover and interception. Large pervious surface areas in parks allow surface water to infiltrate and recharge the ground water. Also, vegetation in parks provides considerable surface area that temporally intercepts and stores rainwater, allowing some to evaporate before it becomes overland flow. Although the effects of different land cover types on runoff have been well documented in the literature (Moglen and Beighley, 2002), the effects of tree canopy and other park vegetation have not been considered to the same degree. For example, the runoff curve number used in TR-55 only considers grass cover for open space (e.g., park) (United States Dept. of Agriculture, 1986). Existing vegetation (e.g., trees and shrubs cover) in a park can intercept considerable rainwater (Xiao et al., 2000b). Most of the intercepted rainwater will never reach the ground surface and produce surface runoff. Research reported that rainfall interception may exceed 59% for old growth forests (Baldwin, 1938). Urban green spaces function like mini-reservoirs that create additional storage for rainwater. Trees/shrubs directly reduce the amount of precipitation that reaches the ground surface, while grasses and ground covers provide foliar and woody surfaces to which water adheres.

We assume that the problem domain is a park in small urban watershed and the goal is to quantify the runoff reduction for a typical hydrological year attributed to the park's existing park green space (i.e. trees, shrubs, grass, and other vegetation). The park's runoff reduction is calculated from baseline runoff for a hypothetical site with the same land area as the park, but with land cover that is typical of surrounding development. We adjust the baseline site's surface permeability index (the ratio of the total pervious surface area to the total study area) based on the mix of surrounding land use to create the baseline. The model requires basic site information (i.e., location, area, land cover, and vegetation cover) provided by the user. The total amount of storm runoff and the amount and value of runoff reduction due to the existing park or proposed green space are shown in the spreadsheet template. The model was designed for Washington, D.C. and Boston, MA but can be adopted for use in other geographic regions.

METHODS

Storm Runoff

Urbanization covers large natural pervious areas with impervious areas and causes large volumes of excess storm water runoff because of reduced surface detention storage and infiltration. The excess runoff causes flooding, water pollution, and groundwater recharge deficits. The important hydrologic role of parks in the urban landscape has been well described but not quantified in detail. Parks reduce runoff in three ways. The large pervious surfaces provide pathways for surface water infiltrate and recharge groundwater. Vegetation (trees, shrubs, and grasses) in the parks intercepts rainfall, thus reducing net precipitation. Vegetation in the park increases landscape surface roughness that reduces surface runoff flow rate.

TR-55, developed by the Soil Conservation Service's (SCS), has been widely used for calculating storm runoff of small watersheds. Precipitation, soil, and surface cover are considered to determine the amount of runoff from a given storm. This method is based on a dimensionless hydrograph and is widely used to estimate runoff for small watersheds. Assuming the impervious covers in the park are unconnected directly to the drainage system, the TR-55 assumes a relationship exists between accumulated total precipitation (P), direct runoff (Q), and infiltration occurring after runoff begins (F), as well as an initial abstraction I_a:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad (1)$$

where S is potential abstraction which is related to runoff curve numbers CNs by CN=1000/(S+10). I_a can be estimated as 0.2S. Substituting 0.2S for I_a into equation (1) gives:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad (2)$$

In urban watersheds, land use, soil, and land cover type have the most influence on the CN. Parameters used for calculating runoff are discussed in detail in following sections.

Precipitation (P)

The amount of precipitation for a given storm event can be obtained from local (county or city) hydrologic manuals or from the ***Precipitation-frequency atlas of the United States*** (Hershfield, 1963; Miller et al., 1973). Research indicates that once a tree crown is saturated it provides little additional storage (Xiao et al., 2000a). Typically, saturation occurs after the first 1-2 inches of rainfall have fallen. This model estimates annual runoff reduction with hourly annual precipitation from each study city (Xiao et al., 1998). The annual typical weather year was determined based on historical precipitation and air temperature for each city (Xiao and McPherson, 2002). The typical weather year for Washington D.C. was 2004, when annual precipitation totaled 45 inches (1,154.4 mm) compared to the historical average of 43 inches (1088.4 mm). The year 2003 was selected as the typical weather year for Boston, when annual precipitation totaled 44 inches (1,035.8 mm). Precipitation data were preprocessed to isolate individual storm events, defined as followed by at least 24 hours without precipitation (Xiao et al., 1998). The amount of precipitation was recorded for each event. Storm events were designated to occur either during the leaf-on period (from March 15 to November 15) or the leaf-off season. In conjunction with the Forest Service's development of i-Tree (see www.iTreetools.org), we are in the process of developing similar rainfall data for reference cities in 19 U.S. climate zones (Table 1, Figure 1).

Table 1. Climate Zones of the United States

Climate Zone	CITY	STATE
Northern Mtn & Prairie	Bismarck	North Dakota
Pacific Northwest	Portland	Oregon
Upper Midwest /New England	Minneapolis	Minnesota
New England	Portland	Maine
Temperate Interior West	Boise	Idaho
Midwest	Chicago	Illinois
Interior West	Salt Lake City	Utah
Northeast	New York	New York
Northern California	Sacramento	California
Lower Midwest	Wichita	Kansas
South Central	Memphis	Tennessee
Subtropical	Santa Monica	California
Lower South	Atlanta	Georgia
Southwest Desert	Phoenix	Arizona
Gulf Coast	Houston	Texas
Central Florida	Orlando	Florida
Tropical	Miami	Florida

Potential Retention Storage (S)

Potential retention storage S is related to the soil and cover condition of the watershed through the CN. The factors that mainly influence the CN are soil type, land cover type, hydrologic condition, and antecedent runoff condition.

The CN numbers are affected by both soil and land use type. Soils are classified into four different hydrologic soil groups to indicate the minimum rate of infiltration (Table 2). Soil names are from the USDA soil texture classification. Users input the percentage of the park area that is occupied by each soil group. Most park managers know what types of soils occur in their parks. However, the specific type of soil information is frequently available from soil maps and experts at the local Natural Resource Conservation Service.

Table 2. Hydrologic Soil Group	
Soil Group	**Soil textures**
A	Sand, loamy sand, sandy loam
B	Silt loam, loam
C	Sandy clay loam
D	Clay loam, silt clay loam, sandy clay, silty clay, clay

Land Cover Type and Coverage

Land cover types are often classified as pervious (e.g., lawn, bare soil, unpaved road, unpaved sports area), impervious (e.g., paved parking lots, roads, paved sports area, building roofs), and water. For modeling purposes, park managers must determine the percentage of each land cover type as listed in Table 3. Land cover (LC) type estimates can be taken from aerial photographs using methods described by Miller and others (Miller et al., 1973).

Table 3. Land cover

Land cover type	Area (acre)
Pervious surface	LC_p
Impervious surface	LC_{ip}
Water	LC_w

Runoff CN Number

Table 4 lists runoff CN numbers used in the model for different land cover types and soil groups assuming average antecedent runoff conditions. The impervious surfaces were assumed to not be connected to the drainage system.

Table 4. Runoff curve numbers for urban areas

Land cover	Curve numbers for Hydrologic soil group			
	A	B	C	D
Pervious surface	39	61	74	80
Impervious surface	98	98	98	98
Water	100	100	100	100

The composite CN number of the study area is calculated based on a weighted average by area.