C. Initial Planning Investigation

The initial planning investigation consisted of developing an analysis methodology or process, identifying sources of information to facilitate the analysis, conducting a gap analysis to determine what information was not available, and generating preliminary spatial analyses through mapping. The planning approach conducted by the team was based on ecological principles and systems. By standardizing source spatial information, identifying the criteria or factors that are important in the context of the project's four issue areas, and combining diverse sources of information to reveal new patterns, the project team generated five suitability, or probability models from which planning recommendations will be generated.

The Ecosystematic Planning & Design Process

The *ASWRFS* is being undertaken from the perspective that watersheds function as geographic and ecological units. This approach is also based on the supposition that natural and human landscapes can be described using a similar, ecosystem-based approach, one which derives primarily from the field of ecology, but which has been gradually integrated in the past few decades into various fields within the broader discipline of environmental design. Rather than focusing on the disparities and duality of natural and human-made landscapes, the project team's approach to this study derives from an assumption that the Arroyo Seco watershed comprises one large, integrated system in which all components, to some varying degree, are interrelated. It is also recognized that the watershed is not an isolated entity but one that is linked to other landscape units. In order to understand the watershed, the project team's approach to this study is based on describing the watershed in terms of its physical structure or form; the processes, functions or flows that take place within and beyond the watershed boundary; and the dynamics which affect the change of watershed through time.

In the book *Design for Human Ecosystems* (1985), the late John Tillman Lyle outlines a design process in which natural systems can co-exist with human systems. The principles of ecosystematic design provide the basis for this project. Through an ecosystem-based design process, it is the intent of the project to shape the structure of the watershed's landscape to guide watershed processes toward a trajectory of change through time which will balance the needs of the floral, faunal and human inhabitants and their environments. An ecosystem can be described as the interacting assemblage of living things in a given space and their nonliving environment (Forman and Godron 1986, Lyle 1985). Though this may imply that an ecosystem is a unit that is closed or discrete in its boundaries, it is important to keep in mind that ecosystems are open systems. They do not stand alone. The understanding of the connections between adjoining and overlapping ecosystems and dynamics between them are critical to understanding any ecosystem. It is also important to understand that humans and their activities are an integral part of most living ecosystems. The Arroyo Seco Watershed ecosystem interacts with the Los Angeles River, the San Gabriel Mountains, the San Rafael Hills, and the San Gabriel River watershed.

Central to this process are four criteria upon which success of a planning process is measured: capacities for complexity, predictability, defensibility, and communicability. Ecosystems are complex. The ability to use and synthesize a great deal of information from various disciplines is required to analyze and plan for them. The ability to estimate the potential effects of design

alternatives is critical in the ecosystematic design process. Also important is a clear and logically correct framework of objective observations that will support the final recommendations. Integral to this process is the participatory inclusion of people who are affected by the final recommendations. Lastly, a successful ecosystematic design process is communicated in a clear, often graphic way that is understood by the general public.

Three organizational concepts guide the structure of ecosystematic design. The first concept is *scale*. The Arroyo Seco watershed comprises a workable scale, because it can easily be traversed in one day; it is not so large that it cannot be easily inventoried. Next is *design process*, the pattern of thought applicable to the ecosystem scale. Lyle divides the *design process* into three stages: the stage of romance, the stage of precision, and the stage of generalization. These are discusses further in the following section. Finally, *order* "binds ecosystems together and makes them work" (Lyle 1985). To understand order, we need to understand the structural, functional and locational elements of an ecosystem.

The stages of the ecosystematic design process can be described in many ways. In the context of this project, the team is utilizing a three stage process (Lyle 1985). In the first phase, the *stage of romance*, members of the project team spent time together and spent time being intimate with the site. Together, members of the team hiked, walked, drove and photographed the watershed. Also important in this early stage, were the discussions, debates and charrettes to solidify a common vision, goals and objectives. Moving from this *stage of romance* to the *stage of precision*, members of the planning team began mapping and developed suitability models. Suitability models are analytical maps showing relative suitability (high, medium, low) of a particular human activity or natural system. In our case, the project vision calls for an integration of flood management, stream naturalization, water resources, habitat rehabilitation, and educational and community recreational opportunities. It is in this stage, through mapping and modeling, that the planning team begins to comprehend the structural, functional, and locational elements of the watershed. In Phase II, during the *stage of generalization*, the team will synthesize all of the information from the first two stages to develop a Master Plan with demonstration project sites identified and management recommendations.

Draft Spatial Analysis Process

The Draft Spatial Analysis Process Diagram (Figure 9) illustrates the general relationships between the project technical studies or models. Developed by conservation ecologist Verna Jigour, this overall diagram illustrates the interdependencies between various components of the study. For example, a particular habitat restoration scenario may alter or influence a flood management aspect of the stream naturalization scenario. As Jigour states in Figure 9, "Running the range of scenarios through (for example) the water budget model will test what degree of watershed restoration is necessary to allow naturalization of the Arroyo Seco and perhaps some of its urban tributaries." Therefore it is important to note that although the project distinguishes between four distinct technical studies, their inter-relationships will become obvious as various scenarios and alternatives are developed in the final phase of this project.

Arroyo Seco
Watershed Restoration
Model Scenario Alternatives

A range of degrees of watershed restoration should be considered, with increases in pervious surfaces/ decreases in runoff rate being the measure of restored watershed function.

For example, the lowest degree might include a few parking lots converted to permeable paving, some runoff filtration areas; along with restoration of deeper-rooted native vegetation to some areas currently occupied by shallow-rooted non-native vegetation; and perhaps one demonstration floodplain expansion & naturalization. The highest degree of watershed restoration would include widespread use of rain-collecting cisterns, rooftop gardens, permeable paving and other stormwater BMPs; increases in pervious open space, with restoration of native communities and associated watershed function; and floodplain expansion at all feasible locations.

Running the range of scenarios through the water budget model will test what degree of watershed restoration is necessary to allow for naturalization of the Arroyo Seco and perhaps some of its urban tributaries. Some degree of naturalization will be necessary in order to restore the system's ability to sustain native fish and amphibian, as well as other wildlife populations. While we cannot recreate the exact conditions that once supported steelhead, for example, we may be able to emulate them in new ways.

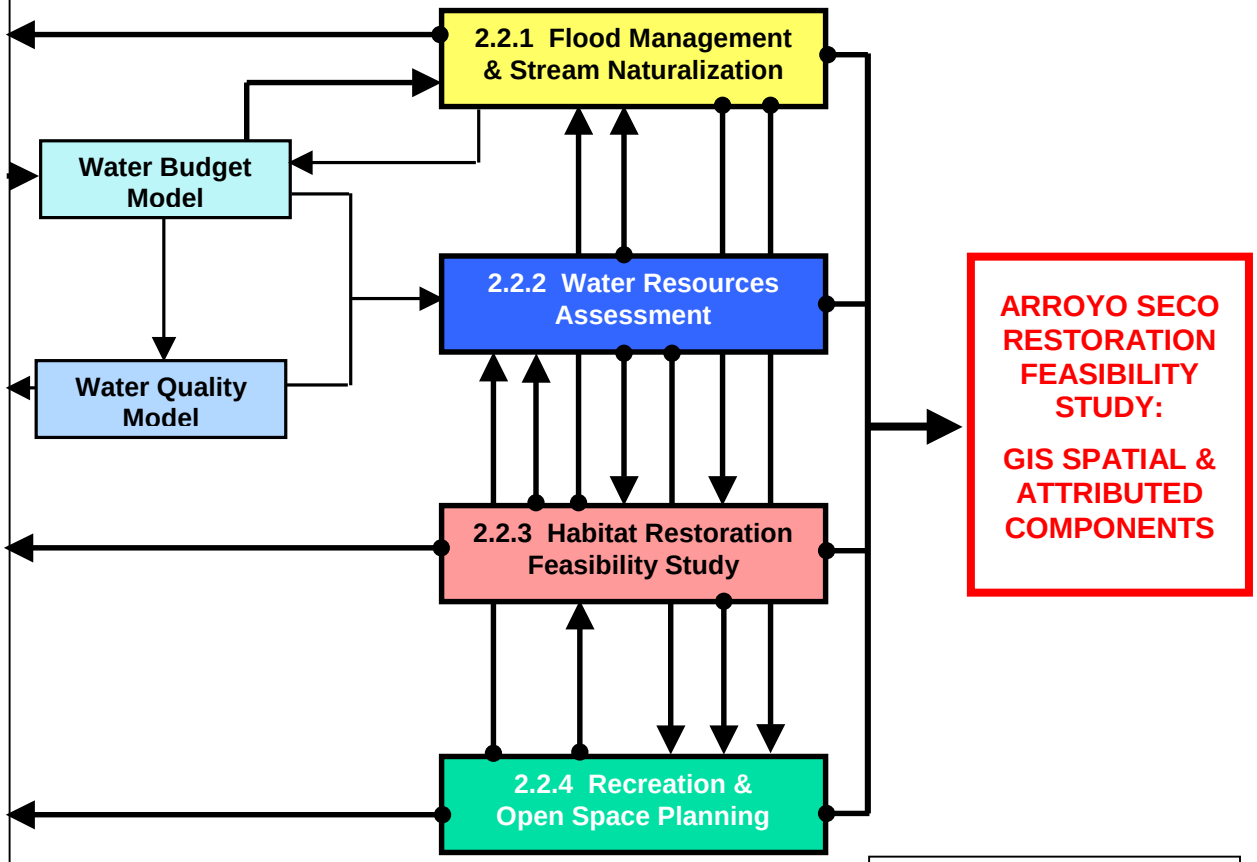

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Figure 9
Draft Spatial Analysis Process Diagram: Overall Process

In Appendix E, Jigour further breaks down each of the five models into a spatial analysis flow diagram. These flow diagrams guide the data collection, mapping and analysis for this project. They serve as a flexible framework that can be adjusted as data becomes available or not available. These diagrams read from left to right. Base data, shown on the left side, include information such as land use, topography and stream channels. After the base data, arrows converge into analysis maps or models, which combine into further analysis models, result in a final model, such as a Water Resources Assessment – Water Budget Model.

Data Gap Analysis

The available hardcopy data used at the time of the preliminary mapping and analysis was limited. Land use data from SCAG, geology maps from USGS, USGS topographic maps, and aerial photographs were readily available at 1 inch equals 2000 feet scale. As shown on the Initial Resource Analysis Diagrams, much of the needed information still needs to be collected (Table 5: Data Gap Analysis). In the final analyses, not all data layers may be used per the diagrams. The diagrams serve as a framework, and final analyses will occur with all available data.

Table 5: Data Gap Analysis

Information/Data Need	Currently Available	Data Gap and/or Action Plan
Flood Management and Stream Naturalization Feasibility		
Localized Flood Potential: Existing & Alternative Model Scenarios	From Water Budget Model	
County Flood Zones/FEMA flood Insurance Maps	No	Should be available from LACDPW
Locations of County-Identified Inadequate Channel Capacity	Yes	
Gaging Stations/Other Flow Rate Stations	Yes	
Locations/Estimated Amounts of Sediments Trapped Behind Dams	No	Should be available from LACDPW
Land Ownership/Parcel Data	No	Should be available from LACDPW
Montgomery Watson Harza Additional Data	See Page 56	
Water Resources Assessment		
Subwatersheds	Yes	
Water Recharge Zones	Yes	
Artesian Source Locations	No	Need to research data availability from local sources
Slopes	Yes	
NRCS Soil Types	Yes	
Vegetation Types	Available for Angeles National Forest, Debs Park being developed by City of Pasadena	South Pasadena, Alta Dena, and Los Angeles need further investigation

Table 5: Data Gap Analysis		
Information/Data Need	Currently Available	Data Gap and/or Action Plan
	and Debs Park	
Land Use and/or Cover	Yes	
Stream Channel Locations/Capacity	Yes	Need additional data from LACDPW
Storm Drain Locations/Capacity	Yes	Need additional data from LACDPW
Seasonal Wind Patterns	No	Need further investigation
Roads	Yes	
Vegetation/Landcover	Yes	
Zoning/GP/USFS Designations	No	Should be available from local cities
Land Use	Yes	
Land Ownership	No	Should be available from LACDPW
Subwatersheds	Yes	
Blue Line Drainages	Yes	
Storm Drain System	Yes	
Documented Locations of Urban Water Quality Problems	No	May not be available
Habitat Restoration Feasibility Model		
Land Ownership/Parcel Data	No	Should be available from LACDPW
Slopes	Yes	
Soils	Yes	
Transportation Opportunities/Constraints	From Open Space Process Model	
Land Use	Yes	
Vegetation/Landcover	Yes	
CNDDB Occurrences	No	Available from CNDDB
Subwatersheds	Yes	
Blue Line Drainages	Yes	
Water Management Infrastructure	Yes	
Recreation and Open Space Feasibility		
Zoning	No	Should be available from local cities
Digital Orthophotos	Yes	
Land Use	Yes	
Land Owership/Parcel Data	No	Should be available from LACDPW
Transportation Plans	No	Should be available from local cities
Road/Railway	Yes	
Existing Trails	No	In phase 2 work plan
Watershed Management	Yes	

Table 5: Data Gap Analysis		
Information/Data Need	Currently Available	Data Gap and/or Action Plan
Infrastructure		
Blue Line Drainages	Yes	
Subwatersheds	Yes	
Zip Codes	Yes	

Initial Resource Analysis

The Initial Resource Analysis created models of potential for each of the four primary goals of the *ASWRFS*. These are described on the following pages. The progress described here falls under the *stage of precision*. The Initial Resource Analysis was a two-step process. First, analysis maps or models showing relative suitability (high, medium, low) of a particular human activity or natural system were created. These analysis maps were refined with the project team's knowledge of constraints, so that the Initial Research Analysis shows the relative potential for each goal in the watershed.

To come to an understanding of where opportunities and constraints exist within the watershed, a spatially-based analysis was undertaken. The potential mapping developed for flood management, habitat restoration, recreation, water quality and water recharge revealed some of the structure of the Arroyo Seco watershed ecosystem. This type of mapping plays a key role in ecosystem design. These models inform the planning and design process by providing a means by which to aggregate diverse and extensive information in such a way as to reveal new patterns that could not otherwise be observed (Lyle 1985).

To better understand the mapping process it is easiest to discuss the maps in terms of their order. First order maps are the most objective type of base maps. These are the maps that are least likely to be altered by opinion. Soils, streams, topography, land use, jurisdictional boundaries, and other base information give the most objective overview of an area. Second order maps are the first step in analysis and require that some subjective criteria be placed on one or more first order maps. For example, from a first order geology map, more and less permeable areas can be mapped simply by grouping alluvial areas for permeable, and granitic or shale substrate for non- or unlikely areas of permeability. The potential models in this report represent second or third order maps. These maps are generated from a combination of first and second order maps for further analysis.

Available hardcopy maps such as USGS topographic quadrangles, SCAG land use, and aerial photographs were used as base information. Five maps were developed which depicted high, medium-high, medium, and low potential. The five maps, based on project goals and objectives include: Habitat Restoration, Flood Management/Stream Naturalization, Water Supply/Recharge, Water Quality and Recreation (see Analysis Process Diagrams). This first round of analysis mapping was developed with hand-drawn maps. Once GIS data collection is completed, more detailed analysis will be conducted. The Analysis Process Diagrams show as colored boxes which themes (i.e. GIS data map layers) were available at the time of the Phase I analysis. As more data becomes available, refinement of this modeling process will occur in Phase II.

Flood Management/Stream Naturalization

The goal of the Flood Management/Stream Naturalization component is to restore the natural hydrological functioning of the watershed through non-structural approaches to flood management while reducing existing flood hazard conditions. Stream naturalization is the primary alternative that will be examined. One way to look at the goal is to restore hydrologic functioning of the Arroyo to support the migration and spawning of the southern steelhead trout. Areas with varying degrees of suitability towards this end were identified (Figure 10: Potential for Stream Naturalization).

The first order maps for this analysis include USGS topographic quadrangles and SCAG land use designations. A second order map depicting a generalized floodplain along the Arroyo Seco was modeled using contour lines from the USGS quad. This generalized floodplain was developed by assuming floodwater 20 feet above the edge of the Arroyo Seco channel. Land use was overlaid onto the floodplain to determine locations of suitability for flood management possibilities. Areas in open space were given a high ranking. The specific criteria for the Potential for Stream Naturalization is shown in Table 6: Flood/Stream Criteria.

Table 6: Flood/Stream Criteria	
High	In floodplain, open space adjacent to the channel (in Arroyo Seco and tributaries)
Medium/High	Open space in other areas of the watershed (can make multi purpose-can provide opportunities for storm water capture and retention)
Medium	Developed lands in floodplain (as properties become available for purchase, can be bought and demoted)
Low	All other areas-we anticipate that neighborhood scale BMPs can provide significant opportunities/benefits at the local level

Habitat Restoration

Linking the San Gabriel Mountains with the Santa Monica Mountains and to the coast through a wildlife corridor along the Arroyo Seco is a primary goal of habitat restoration. Through conservation and restoration of critical gaps in a wildlife corridor, restoration of aquatic species from tiny macroinvertebrates to southern steelhead trout, and the restoration of a sustainable riparian corridor, the opportunity exists to reestablish a viable, regional habitat network utilizing the Arroyo Seco.

In the spatial modeling, first order base information used in the preliminary analysis included the USGS topographic quadrangle map and a SCAG land use map. In developing the mapping criteria for Potential for Habitat Restoration, continuous open space, especially along the Arroyo Seco was ranked higher than isolated patches of habitat (Table 7: Habitat Criteria, Figure 11: Potential for Habitat Restoration). Undeveloped open spaces with vegetation were rated higher

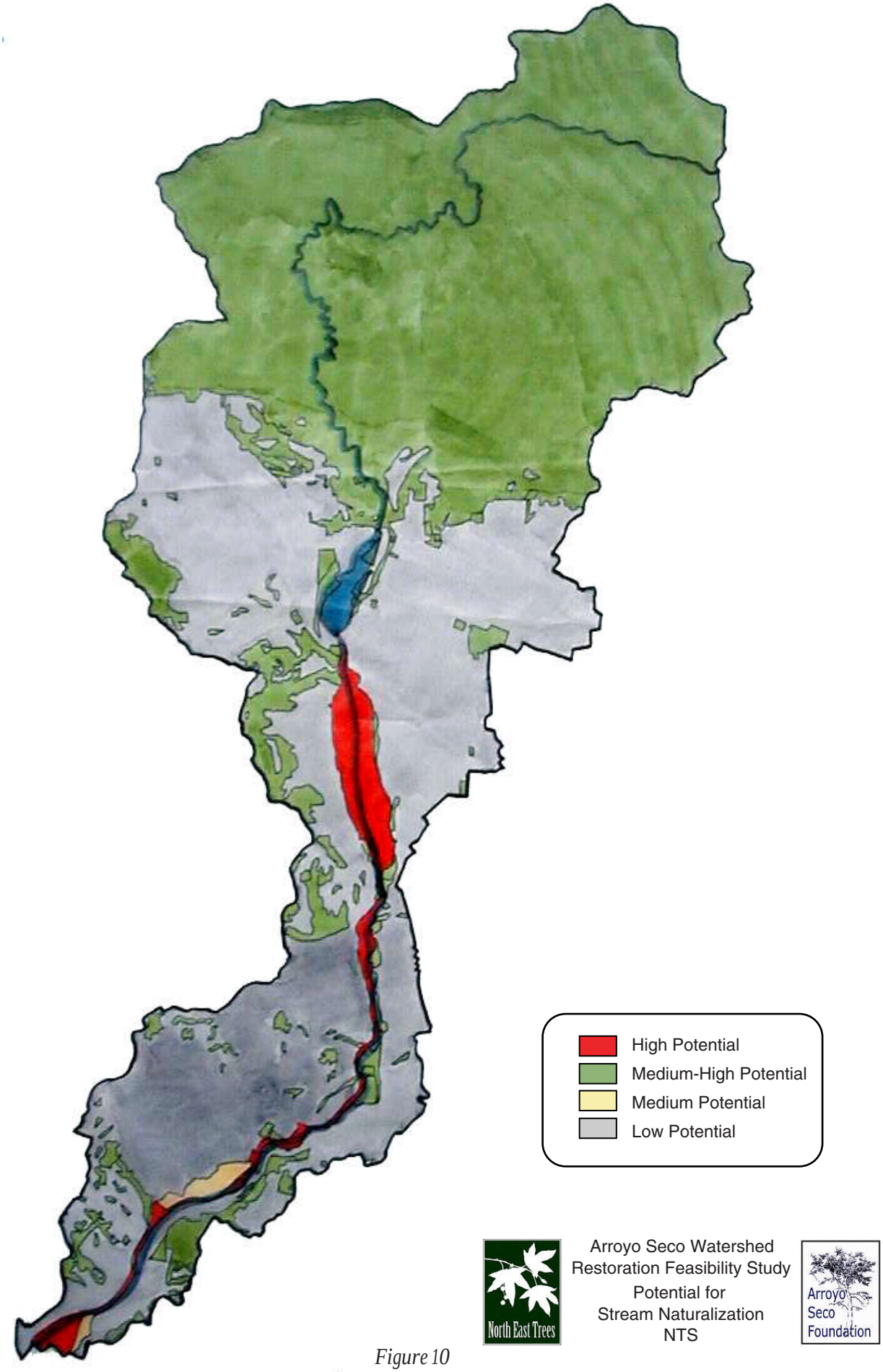
High Potential
Medium-High Potential
Medium Potential
Low Potential
North East Trees
Arroyo Seco Watershed
Restoration Feasibility Study
Potential for
Stream Naturalization
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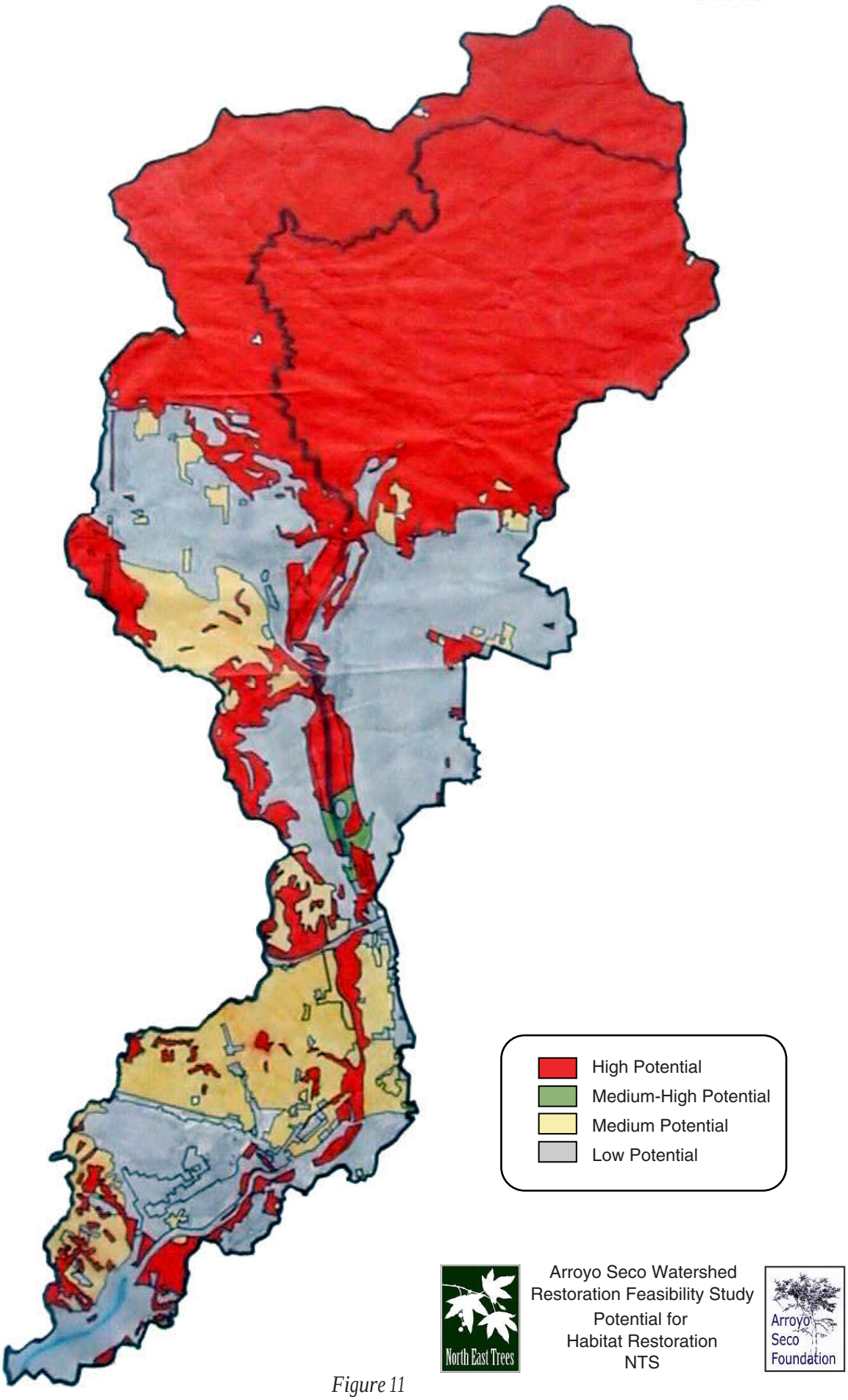
Figure 10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Arroyo
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Figure 11

than unvegetated open space. Land uses with some open space such as schools and low density residential have some potential for habitat. Patches of open space were overlaid onto the aerial photograph for current vegetation patterns.

Table 7: Habitat Criteria	
High	Vegetated open space (can be enhanced), presence of water (attracts birds, some herps), golf courses, directly adjacent open space areas
Medium/High	Non-vegetated open space (can be planted)
Medium	Low density residential lands, institutional, ballfields
Low	Higher Density residential / Commercial / Industrial

Recreation

The Initial Resource Analysis for Recreation & Open Space relied primarily on a first-order map of Existing Land Use. A description of the land uses were extracted to identify the potential for open space and recreation amenities (Table 8: Recreation Criteria, Figure 12: Recreation & Open Space, Figure 13: Potential for Protected Open Space).

Table 8: Recreation Criteria	
High	Open space with no programmed recreation facilities, areas adjacent to existing recreational resources/facilities (including trails, rail lines, channels, utility easements, connections), existing public lands, areas adjacent to other open space
Medium/High	Other open spaces or non-contiguous private lands, JPL
Medium	Institutional lands such as schools
Low	Industrial/commercial/residential lands

The Initial Resource Analysis was initially limited to outdoor, passive, nature-based activities, because the potential for these is easily located based on land use. Other types of recreation will be considered during the Phase II analysis. The Phase II analysis, Technical Study, will also consider the relationships of connectivity, open space, amenities and views, as wells as physical characteristics such as slope, aspect, soils, and vegetation. The Technical Study will develop the goal of improving recreational opportunities in the watershed through improved public access and linking trail systems, mediation between passive and active recreation, and restoration of waterfront for public access and use.

Further criteria may be developed based on State Coastal Conservancy and Mountains Recreation and Conservation Authority acquisition criteria.

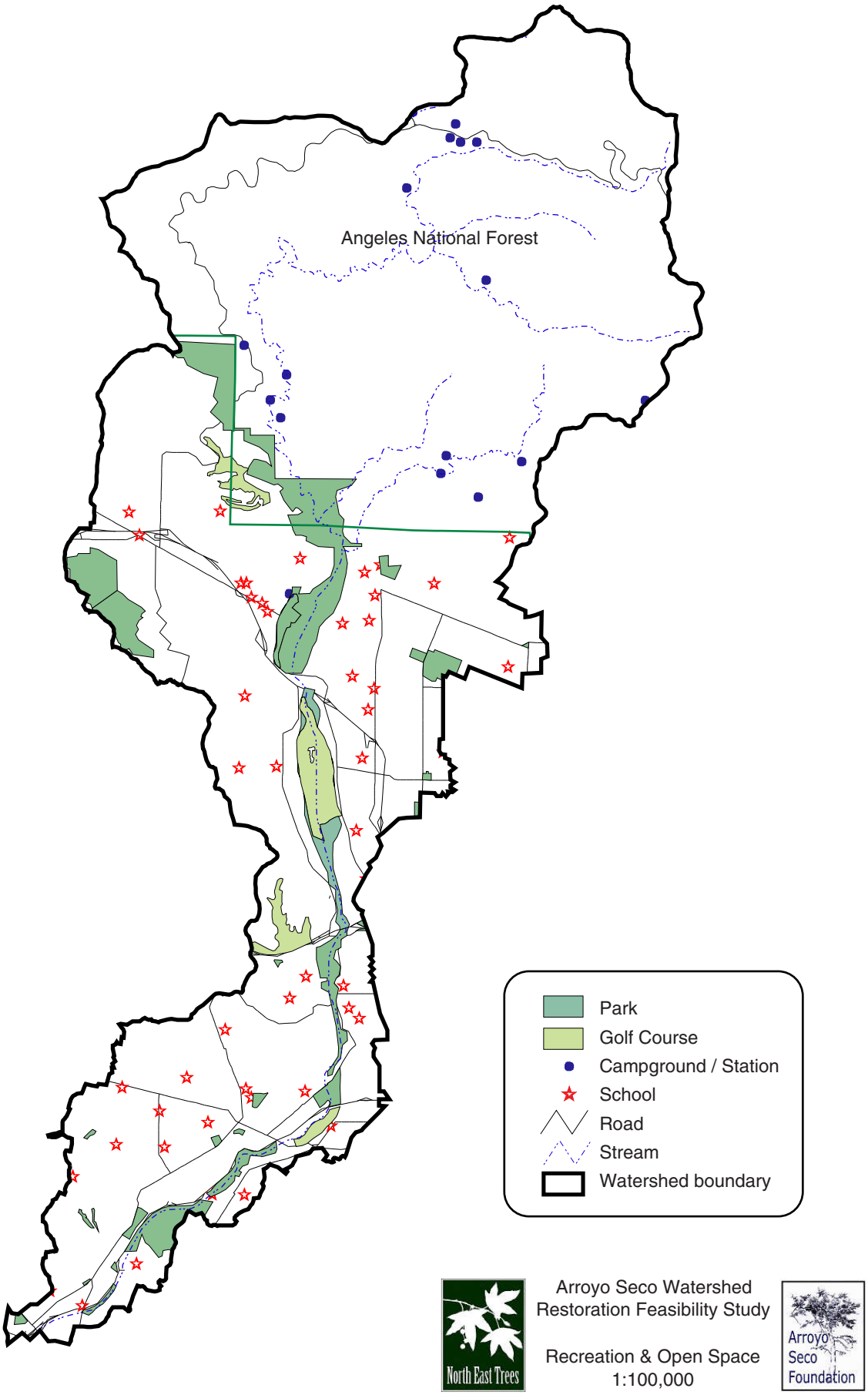
Angeles National Forest
Park
Golf Course
Campground / Station
School
Road
Stream
Watershed boundary
North East Trees
Arroyo Seco Watershed
Restoration Feasibility Study
Recreation & Open Space
1:100,000
Arroyo
Seco
Foundation

Figure 12

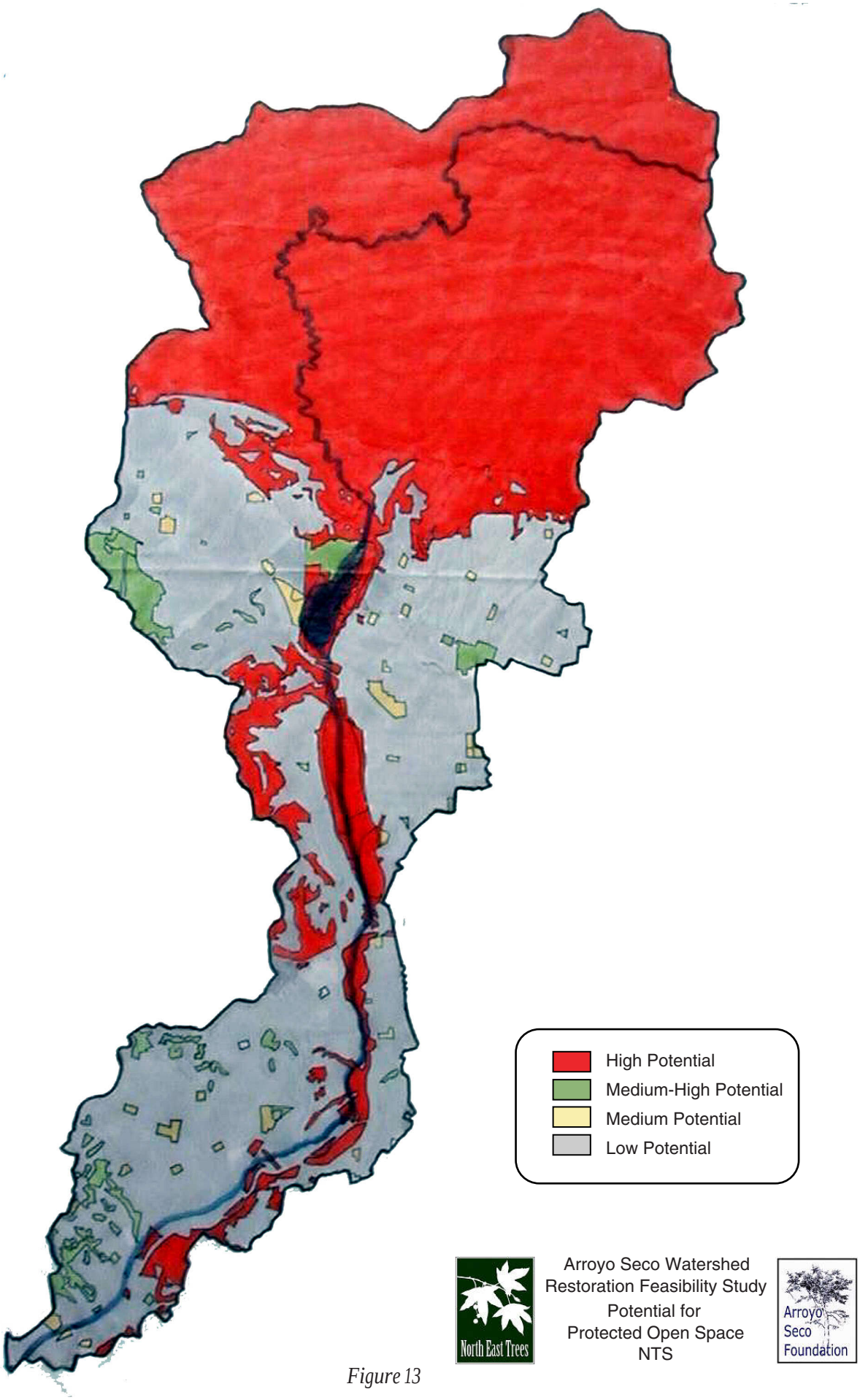
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Figure 13

Water Resources - Quantity

The goals for water resources in the Arroyo Seco are to better manage the resources through optimized use and conservation, and improve water quality. By increasing percolation into the groundwater system, it is assumed more water will become available to the City of Pasadena for local use. The USGS geology quadrangles and the SCAG land use map were the first order maps used. A second order permeability map was developed using the geology maps. Land Use was then overlaid for the mapping of Potential Groundwater Recharge (Table 9: Water Resoruces Criteria, Figure 14, Potential for Groundwater Recharge).

Table 9: Water Resources Criteria	
High	Existing open space on alluvial soils in Raymond Basin
Medium/High	Existing open space on alluvial soils NOT in Raymond Basin
Medium	Developed areas with underlying alluvial
Low	Non-permeable soils (developed and/or open space)

Water Resources - Quality

With the reduction of non-point source pollution, the ability of the Arroyo Seco to support a diverse aquatic ecosystem is increased. Building Best Management Practices (BMPs) throughout the watershed will begin the process of improving water quality in the Arroyo.

Two levels of analysis were developed to model potential sources of water pollution. The first level of analysis involved manipulation of land use information based on the assumption that point and non-point sources of water pollution can be generalized from specific land use types. Low, medium and high probability was mapped, and included the following three categories of probable sources of water pollution:

- Soils or land use with high sedimentation and erosion (i.e. erodible soils, construction areas, recently burned area),
- Urban runoff (based on land uses such as JPL, commercial and industrial areas, high density residential), and
- Nutrification (residential, golf courses, ball fields, highly manicured/irrigated/fertilized areas, horse stables). These assumptions are based on land use as a source rather than specific water quality data.

These probable sources of pollution were synthesized for the second level of analysis to generate a water pollution source map (Figure 15: Potential Sources of Water Pollution). Land use areas that received at least two *high* probability ratings, such as from both urban runoff and nutrification, ranked *high* in this final model. If a land use area exhibited a *high* ranking in only one of the three probability models, such as sedimentation, then it was shown as receiving a *medium* ranking. Areas with an initial *medium* or *low* ranking are shown with a *low* pollution probability in Figure 15.

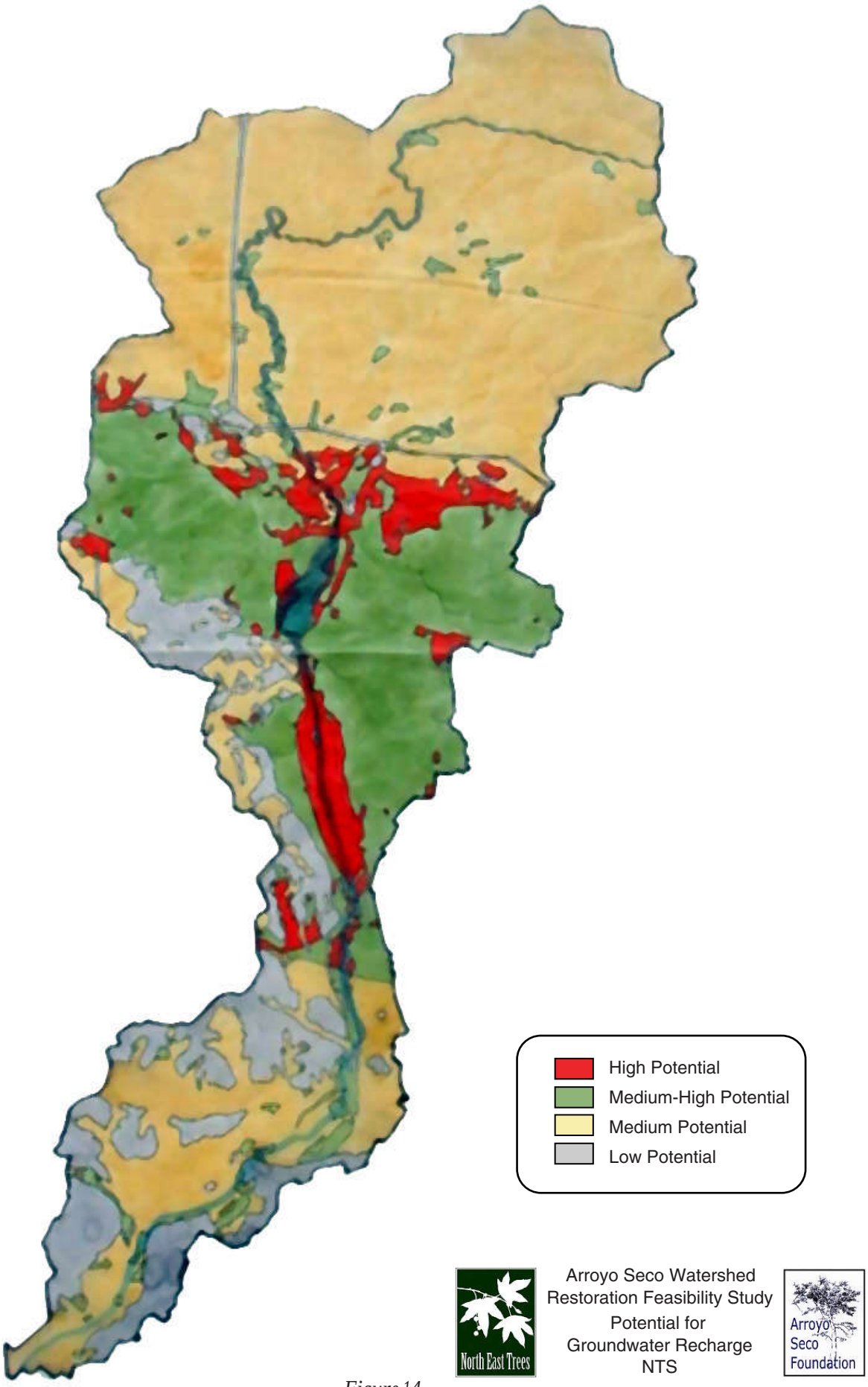
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Figure 14

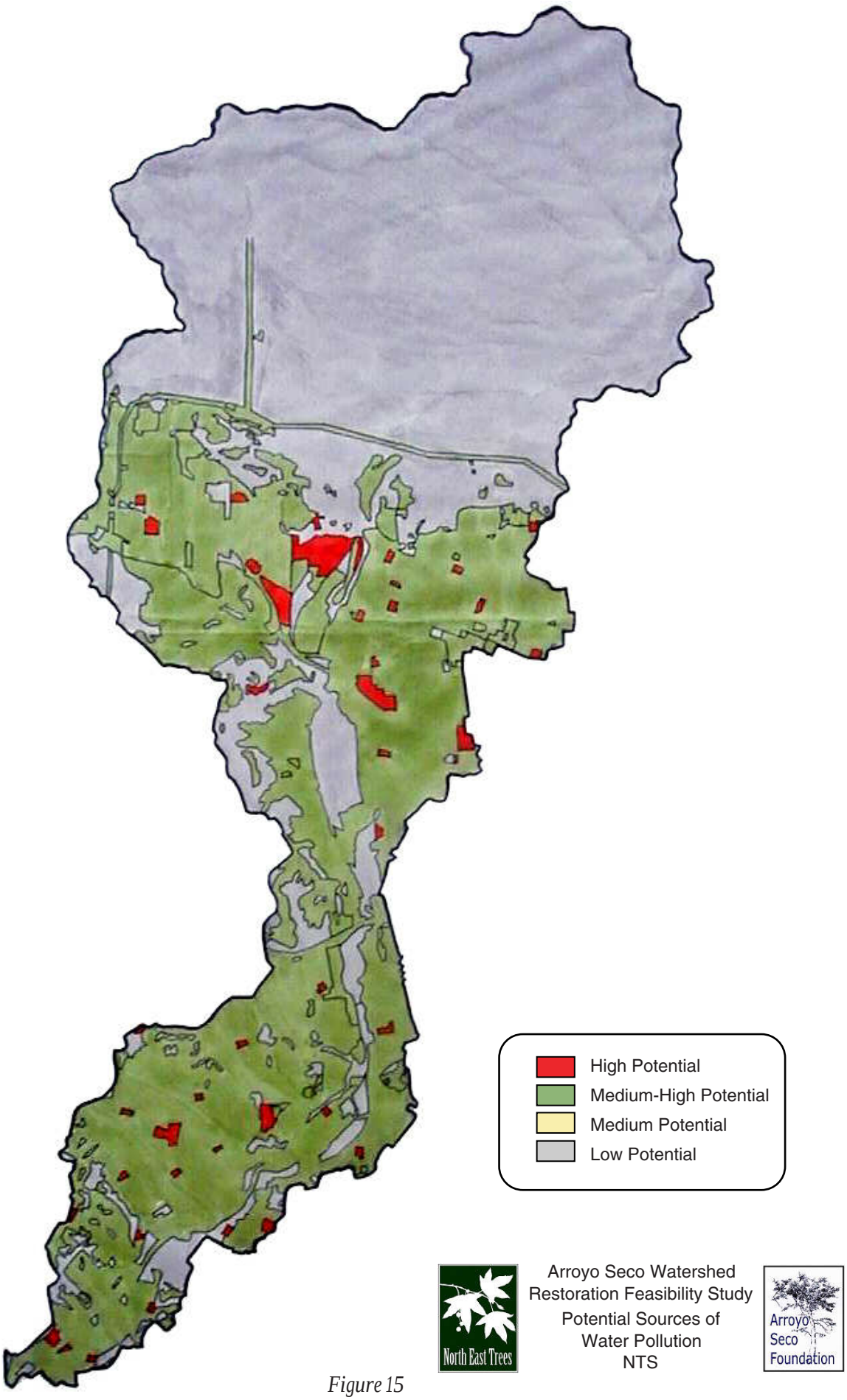
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Figure 15