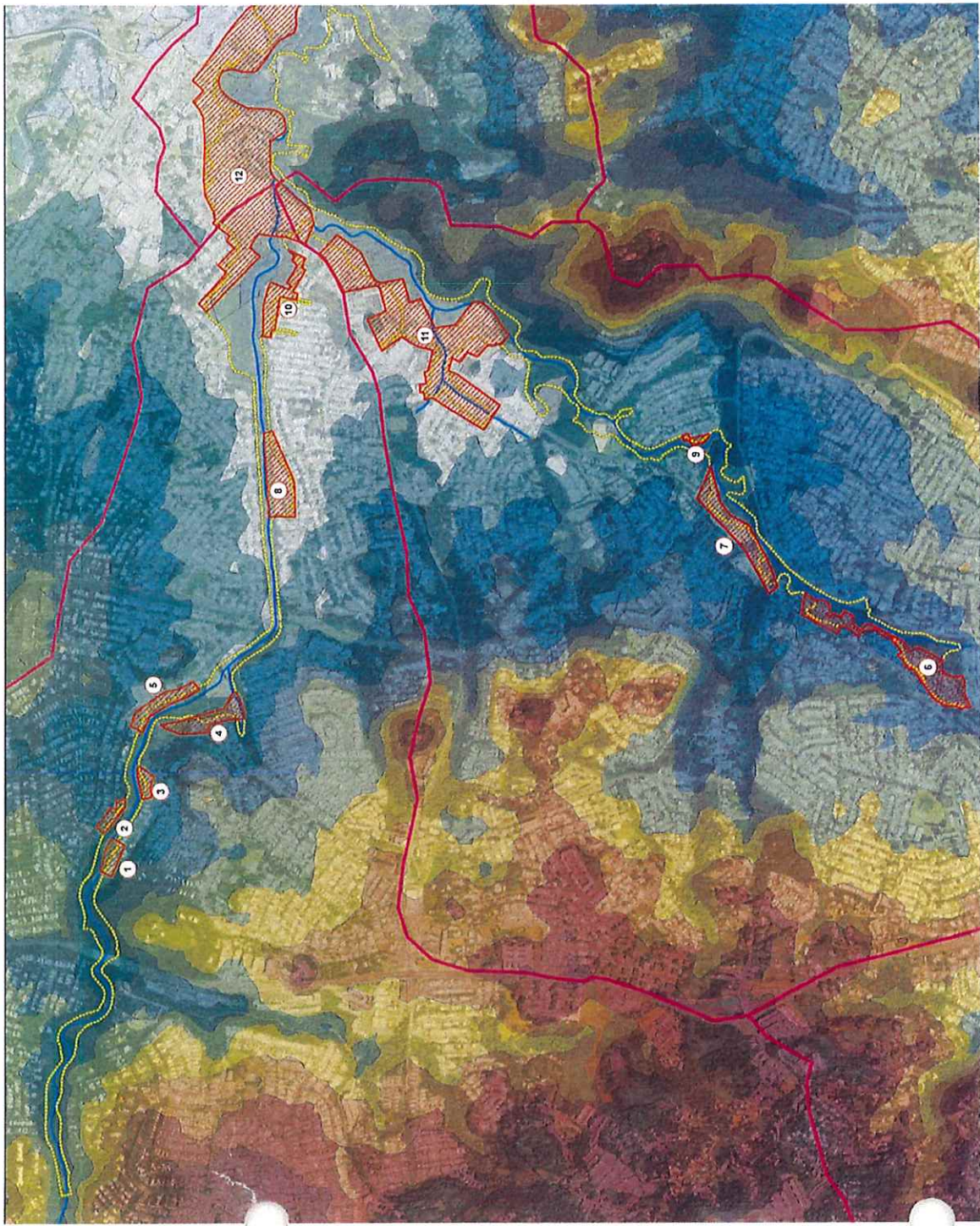




Conservation Trust of Puerto Rico

CONCEPTUAL REPORT

CONCEPTUAL ALTERNATIVES FOR THE RIO PIEDRAS CANALIZATION PROJECT ACUEDUCTO DE SAN JUAN



September 2009

MP ENGINEERS
of PUERTO RICO

in association with

**MALCOLM
PIRNIE**



INTRODUCTION

The Puerto Rico Conservation Trust (Trust) is continuing its planning and investigations necessary to potentially restore and open to the public the historical resources of the property called the Acueducto de San Juan (Acueduct) - the first aqueduct of the city of San Juan. The site proposed for preservation is located within the center of the urbanized greater San Juan Metropolitan Area. The approximate 6-acre site consists of two main parcels located within a riparian greenway of the Las Piedras River and represents an important, and almost vestigial, greenbelt of land situated between the Jardín Botánico and the University of Puerto Rico campus (see Figure A-1 of Appendix A). An important component and source of the Acueduct is the Río Piedras, which is currently the most important water ecosystem within the Municipality of San Juan.

Due to dense development, the Río Piedras has been encroached, limiting its capability of conveying flood flows without impacting adjacent property. The Federal Emergency Management Agency (FEMA) has delineated the areas that lay in the 1% annual chance floodplain which are presented in Figure A-2 of Appendix A. As part of the US Army Corps of Engineers (USACE) initiatives of protecting life and property, they have already begun construction activities in the downstream extents of the Río Piedras, or the Río Puerto Nuevo as identified by the USACE, to channelize the river and reduce flooding. The canalization project is designed to extend through the Acueduct property. The Río Piedras, in the vicinity of the Acueduct property, will be replaced with a concrete channel that will have sufficient capacity to remove properties from the floodplain. The canalization project will also impact the Quebrada Guaracanal which empties into the Río Piedras just upstream of the Acueduct property. However, this will eliminate the entire ecosystem supported by the Río Piedras and the Quebrada Guaracanal and requires the demolition of a significant portion of the Acueduct's structures.

In order to protect life and property, the ecosystem and the Acueduct property, the Trust requested that MP Engineers of Puerto Rico, PSC in association with Malcolm Pirnie, Inc. (collectively referred to as the Design Team) evaluate alternatives to the USACE canalization project and develop concepts that meet the important protection needs.



DEVELOPMENT AND DESCRIPTION OF CONCEPTS

During meetings held between the Trust and the Design Team, concepts for integrating the Trust's efforts with the ongoing USACE canalization project were developed. Concepts focused on the Rio Piedras upstream of State Road PR-1, the Quebrada Guaracanal, and associated drainage areas. Based on pre-conceptual maps presented, that identified the Rio Piedras, its floodplain and the areas affected by the floodplain, the following concepts were developed:

1. Explore opportunities to effect land use management regulations within the Rio Piedras watershed so as to begin reducing the amount of stormwater runoff ultimately reaching the Rio Piedras. This would include strategic acquisition of developed portions of the Rio Piedras and Quebrada Guaracanal floodplain and subsequent efforts to restore those properties to their natural condition. Also included would be the incorporation of low impact development (LID) concepts for new construction, redevelopment and retrofit of existing developments. An example of such restoration efforts is the Trust's current effort to acquire a large warehouse adjacent to the Rio Piedras and State Road PR-176 with the intention of demolishing the building and restoring the property to pre-development conditions.
2. Explore stormwater storage opportunities within the Rio Piedras and Quebrada Guaracanal watersheds upstream of State Road PR-1 to reduce floodflows and associated flooding extents along the Rio Piedras and Quebrada Guaracanal.

As part of the planning process, the Design Team reviewed the best available information (i.e., aerial photography, current regulatory floodplain extents, current Rio Piedras alignment, and historic Rio Piedras alignment) in order to identify:

1. Developed land within the Rio Piedras regulatory floodplain (Federal Emergency Management Agency (FEMA) 1% Annual Chance Floodplain) in the vicinity of the Conservation Trust property;
2. Stretches of the Rio Piedras and Guaracanal that could provide stream restoration opportunities; and,
3. Areas within the Rio Piedras watershed where stormwater storage options potentially exist.

The results of this review are provided in Figures B-1 and B-2 of Appendix B.

The investigation revealed that approximately 64 hectares (157 acres) of property within the regulatory floodplain along the Rio Piedras and Quebrada Guaracanal upstream of



State Road PR-1 are currently developed as compared with a total regulatory floodplain area in the Rio Piedras watershed upstream of State Road PR-1 of approximately 105 hectares (259 acres). Figure B-1 shows approximately 52 hectares (129 acres) of selected developed properties within the regulatory floodplain that could be considered for acquisition.

Stream realignment opportunities that would include restoration aspects are also depicted on Figures B-1 and B-2. These realignment concepts when combined with the other floodplain reduction techniques described in this document present an opportunity to further reduce flooding impacts to properties along the Rio Piedras.

Within the portion of the Rio Piedras watershed upstream of State Road PR-1, there is also the opportunity to potentially create approximately 2.2 million cubic meters (1800 acre-feet) of storage. This amount of potential storage was conceptualized using the following approach:

1. Visual inspection of best available aerial photography within the Rio Piedras watershed upstream of State Road PR-1 to identify areas comprised primarily of open space which also have topography suitable to support the construction of a stormwater storage basin;
2. Delineation of the approximate zone of inundation for each area identified under Step 1;
3. Multiplication of each inundation area by 1/3 to account for area lost to embankments and bottom slopes; and,
4. Storage volume estimate for each inundation area assuming a basin depth of 5 meters (16 feet).

While this initial estimate produces a conservative result, the approach is deemed reasonable considering the current level of investigation. The following should be noted:

- Some of the storage areas identified could potentially cause flooding to existing structures making additional acquisition of developed property necessary.
- The estimated amount of available storage is roughly a third of what would be needed to contain 1% annual chance floodflows within the current Rio Piedras channel geometry upstream of State Road PR-1 and to largely eliminate property flooding in that area.
- The estimate does not consider the impacts of various storage basins on the timing of peak flows from individual sub-basins within the Rio Piedras watershed upstream of State Road PR-1. In order to adequately predict the impact of storage basins on peak flows within the Rio Piedras watershed as discussed here,



a more detailed hydrologic model is required to meet these conditions and to sufficiently demonstrate the effectiveness of such a solution to the USACE.

The investigation demonstrates that through a combination of land use management and planning, strategic property acquisition and floodplain restoration, channel realignment/restoration, and well placed stormwater storage basins, flooding along the Rio Piedras upstream of State Road PR-1 could be greatly reduced. Additional investigations are necessary to conceptualize the proper combination of proposed measures to achieve a level of flood reduction equivalent to the USACE canalization project.



RECOMMENDATIONS

Based on the conceptual analysis performed, the following recommendations are made:

1. Perform a detailed hydrologic and hydraulic analysis for the Rio Piedras watershed upstream of State Road PR-1 for use in evaluating the impacts of various combinations of flood mitigation strategies. The strategies to be considered would include but not be limited to property acquisition, floodplain restoration, channel realignment and restoration, construction of surface water storage areas, and implementation of land management ordinances resulting in a net reduction in impervious surfaces within the Rio Piedras watershed upstream of State Road PR-1;
2. Generate a flood damage assessment for the Rio Piedras and Quebrada Guaracanal upstream of State Road PR-1 to quantify the annual losses associated with flood damages; and,
3. Use the findings from Recommendations 1 and 2 and available cost estimates associated with the USACE canalization project upstream of State Road PR-1 to develop a plan identifying the most cost effective and ecologically sound approach for addressing known flooding areas along the Rio Piedras and the Quebrada Guaracanal upstream of State Road PR-1.

APPENDIX A

Figure A-1: Ancient Aqueduct Location Map
Figure A-2: FEMA 1% Annual Chance



FIGURE A-1: ANCIENT AQUEDUCT LOCATION MAP
ANCIENT AQUEDUCT OF SAN JUAN

1:20,000 SCALE
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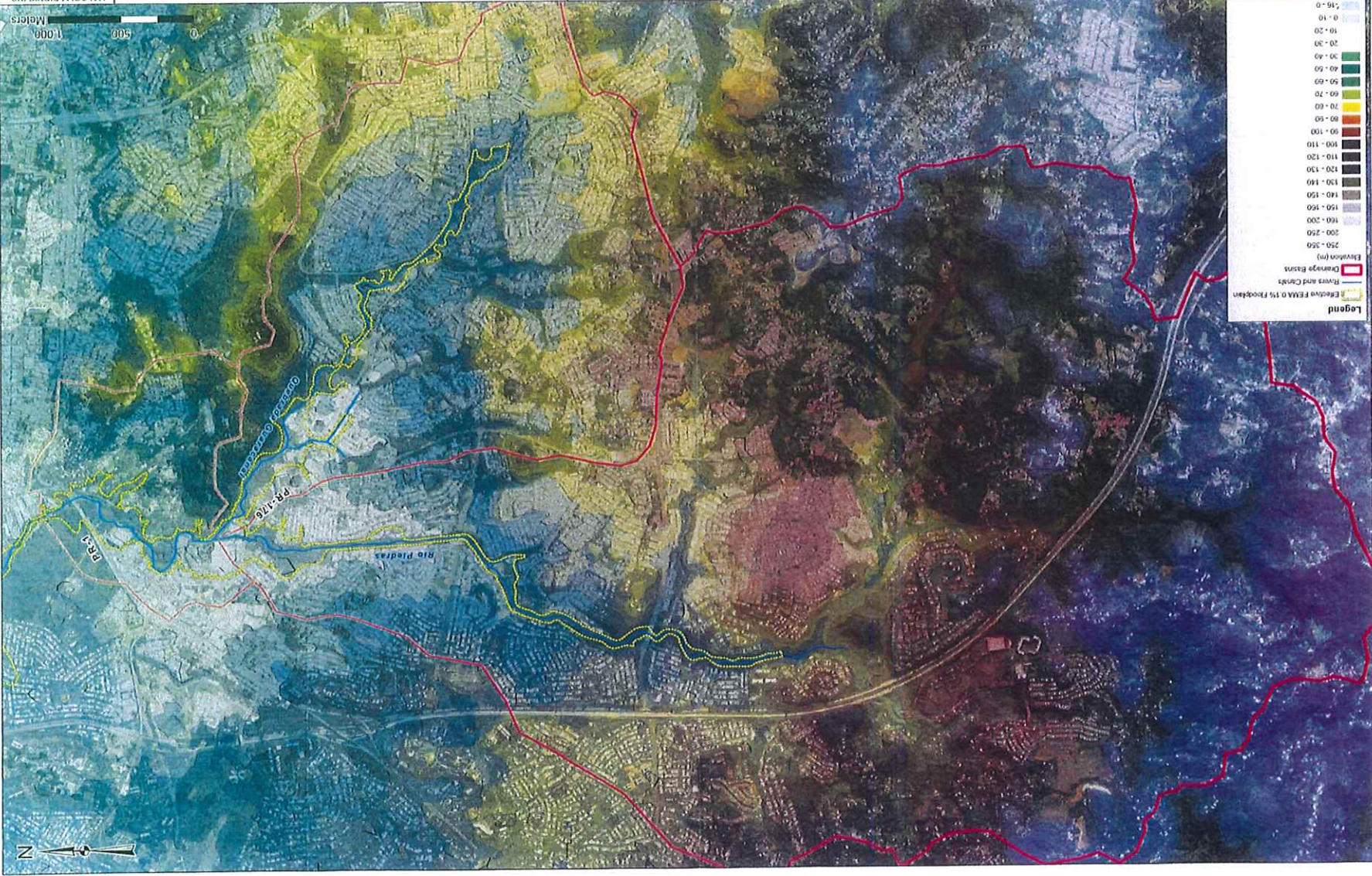


FIGURE A-1: ANCIENT AQUEDUCT LOCATION MAP

ANCIENT AQUEDUCT OF SAN JUAN

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SCALE 1:20,000



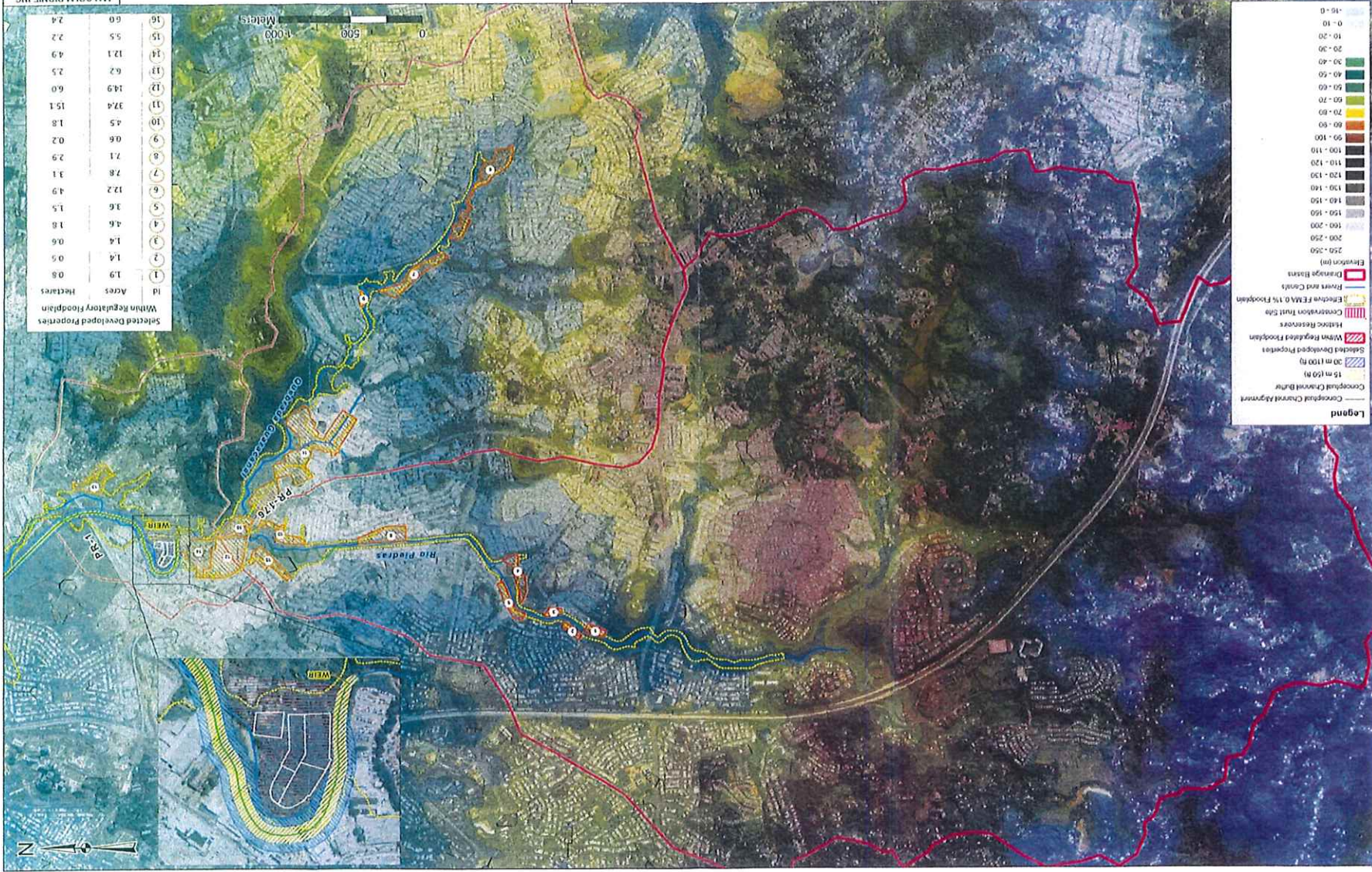


APPENDIX B

Figure B-1: Selected Developed Properties within the Río Piedras and Quebrada Guaracanal Floodplains

Figure B-2: Potential Storage Locations within the Río Piedras Watershed Upstream of PR-1







POTENTIAL STORAGE LOCATIONS WITHIN THE RIO
PIEDRAS WATERSHED UPSTREAM OF PR 1

