

Section 4

Study Approach and Process to Develop Plan

This section describes the process by which the hydroelectric development options were identified, screened, designed, ranked, reviewed for constructability, and analyzed using a variety of economic tools. A primary goal of this study was to target projects that demonstrate immediate viability under the financial and economic incentives available in 2009. One prominent economic incentive for hydro options at existing facilities is the FIT (see Section 2), which was not in place during past investigations such as EID's Energy Recovery Study (Black & Veatch 2007). Another primary goal of this study is to identify additional projects that may be immediately viable, but require further study to assess their feasibility. This latter category includes projects that are more complex, such as those with new water storage features or those requiring reoperation.

4.1 Types of Hydro Options Considered

Hydro options previously studied and new hydro options identified by the County's purveyors, HAP, and consultant team were considered in this study. Some initially identified hydro options were later dropped because they were deemed clearly infeasible at this time. Examples include projects where flows would be insufficient to generate power to economically support the project (e.g., GDPUD's Knickerbacher Creek diversion into the Pilot Creek watershed), projects where substantial hydropower potential exists but public objections would make it infeasible (e.g., Echo Creek cascades into the Tahoe Basin), or new/expanded water storage that would require legislative or regulatory change to allow for construction of the project.

Based on regulatory, economic and other considerations, the hydro options fall into three general categories: 1) FIT options that could be installed immediately at existing facilities with or without the need for water system reoperation, 2) new site options where there are no or limited existing facilities, and which could become multi-purpose with new water storage, and 3) technology demonstration projects that could be readily installed at existing facilities to test or display emerging developments in water-related energy generation technology. These groups of projects are further discussed below.

4.1.1 Feed-In Tariff Options

The CPUC (Resolution E-4137 February 14, 2008) adopted a version of Europe's FIT program to simplify small renewable generators' (less than 1.5 MW) ability to sell power to utilities at predefined terms and conditions, without contract negotiations. As described in Section 2 (Energy Policies Supporting Hydroelectric Generation), sellers receive a fixed base rate determined by the current CPUC-approved MPR for a period of 10, 15, or 20 years. The rates are set and adjusted by Time of Delivery (TOD) factors (for the larger utilities such as PG&E) as authorized by the CPUC. The MPR is the predicted annual average cost of energy production from a combined-cycle natural gas fired baseload proxy plant, which is intended to represent the utility's avoided cost of producing power.

Energy produced during utility peak hours commands a higher price. Conversely, energy produced during off-peak hours is less valuable to the utility and the FIT accordingly. Numerous small hydro projects in El Dorado County qualify for this program and this category represents the majority of options analyzed in detail as the study progressed. Importantly, FIT rates currently are between two and three times spot-market energy values; therefore, a reasonable level of certainty should be established that a hydro option qualifies for the FIT program before substantial resources are expended on that hydro option.

To qualify for the FIT contracts with PG&E, the projects must be certified by the CEC as qualifying for the RPS program for investor-owned utilities. Pre-certification applications can be submitted to and approved by the CEC in advance of project operation. The conditions and processes that hydro options must satisfy to qualify for the FIT contracts, as well as the CEC RPS certification, are presented in Appendix C.

4.1.2 New Site Options, Including New Water Storage

New site options are typically more traditional, long-term, and multi-use hydropower projects. These options include the construction of new small or large storage facilities, providing water for consumptive use as well as drought and fire protection and downstream beneficial uses. In the case of larger impoundments, recreation adds another benefit to these “multi-use” projects. Large capital outlay projects with significant risk to the County’s purveyors for major water storage opportunities were identified in this study. Only the Alder Creek Reservoir option was evaluated to a greater level of detail (see Section 6, Preliminary Project Analyses of Highest Ranked Hydro Options).

Except for the Alder Reservoir component of the South Fork American River (SOFAR) Project, previously studied major water storage alternatives were screened out early because hydroelectric revenues alone were not sufficient to support these projects. Only those hydroelectric opportunities that deliver substantial hydroelectric generation revenues were given the highest priority.

4.1.3 Technology Demonstration Options

This is a relatively small subset of the total hydro options. These projects represent applications of new technology, such as hydrokinetic turbines, that can be deployed rapidly with minimal construction costs at sites where traditional hydropower does not work. These non-traditional opportunities capture minor energy potential with limited head and/or flows. Because these projects have relatively small generating potential and minimal capacity, they were not a major focus of the analysis.

4.2 Hydro Options Evaluation Process

The hydro option identification and evaluation process followed the approach outlined in the consultant's scope of work for the study (Figure 4-1). EDCWA, County water purveyors, HAP, and consultant team representatives (collectively the "Project Team") actively participated throughout the study process. Six meetings were held with both the HAP members and purveyors at key points in the process to review and guide the hydro evaluation process and products. The meetings, products, and input were documented as the study was completed (see Section 10, Study Participants and Meetings Held). The study process steps that were followed to narrow the hydro options from approximately 100 to the final "top 10" are described below.

4.2.1 Hydro Option Identification

The Project Team convened an exhaustive literature search for hydroelectric projects proposed for development in El Dorado County over the past five decades. The list was developed from a combination of sources, including an inventory of the EID, EDCWA, and GDPUD technical libraries. Figure 4-2 summarizes the sources used to compile the initial list of projects. The Project Team interviewed HAP members and Citizens for Water Chair Harry Dunlop, researched existing water facilities not owned or operated by County purveyors (e.g., Sacramento Municipal Utility District Upper American River Project), and consulted with additional individuals and organizations (e.g., Heavenly Ski Resort) with potential knowledge of hydro options in El Dorado County. The results of the hydro identification process are described in Section 5 (Inventory of County Hydroelectric Potential).

The comprehensive list of hydro options was reviewed by and later presented to the EDCWA, purveyors and HAP for concurrence. Over the study process, the initial list of hydro options was modified several times based on new information received by the Project Team. For this study, all projects were included, regardless of costs, so long as the hydro options did not display characteristics that clearly warranted their non-inclusion (see Section 4.1).

4.2.2 Hydro Option Screening Evaluations

The list of hydro options, which exceeded one hundred projects, needed to be reduced to those with the greatest potential. To accomplish this, the next task focused on screening techniques necessary to produce a list of the most viable projects that could be analyzed in greater detail.

Figure 4-1: Overview Process for Evaluating Hydroelectric Development Options

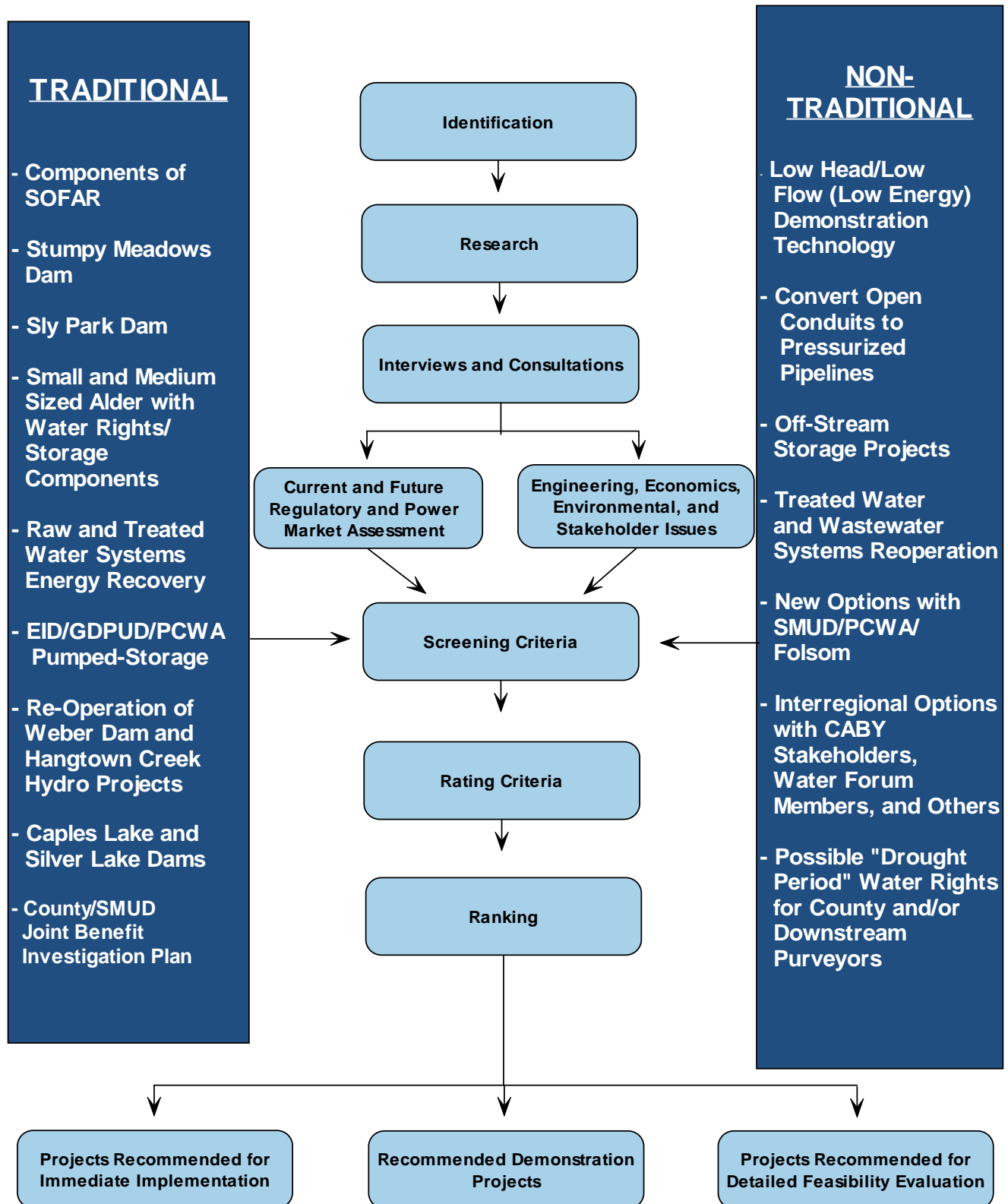
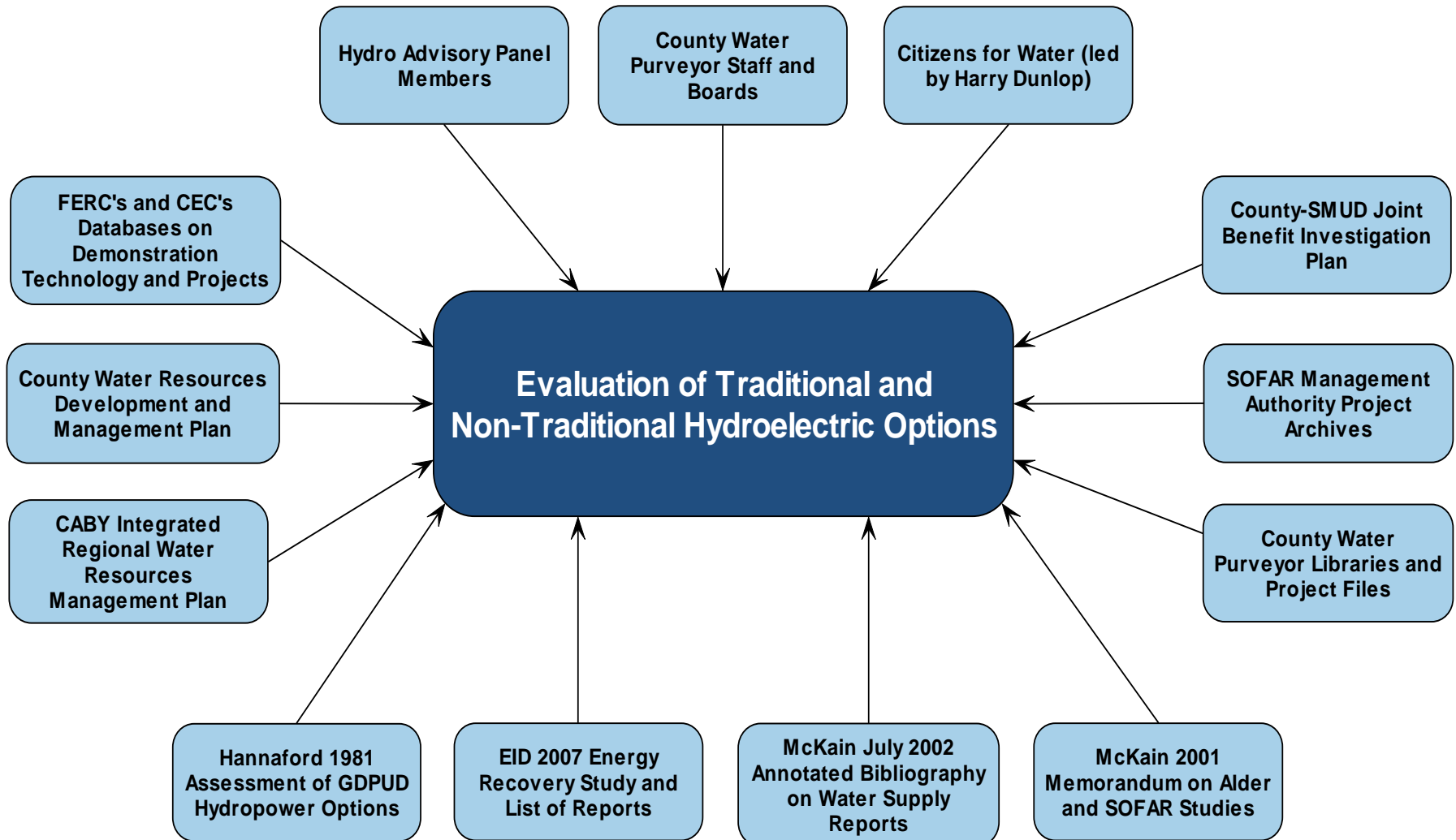


Figure 4-2: Initial Sources for Identifying New and Updating Previous Studies on Hydropower Projects



The projects were placed into a matrix and data was collected for each project using available information from previous studies, existing purveyor records and databases, Project Team knowledge, and existing public data sources. The information developed for the screening matrix included the project type (see Section 4.1), design head and flow, plant factor and capacity, annual generation, previously or newly estimated project costs, and a factor [Capital Cost/Average Annual Megawatt Hours (MWh)] that could be used to compare the relative economic merits of the options.

The consultant team devised a flowchart and considered engineering, operations, environmental, cost, generation potential, site ownership, and other criteria to screen, compare, and rank the hydro options. Initially, the flowchart showed separate paths for FIT options, options at new sites, and options requiring reoperation, but it was determined later that all project options should follow the same review steps. Therefore, the evaluation flowchart was simplified, refined and applied to all hydro options, which is presented as Figure 4-3.

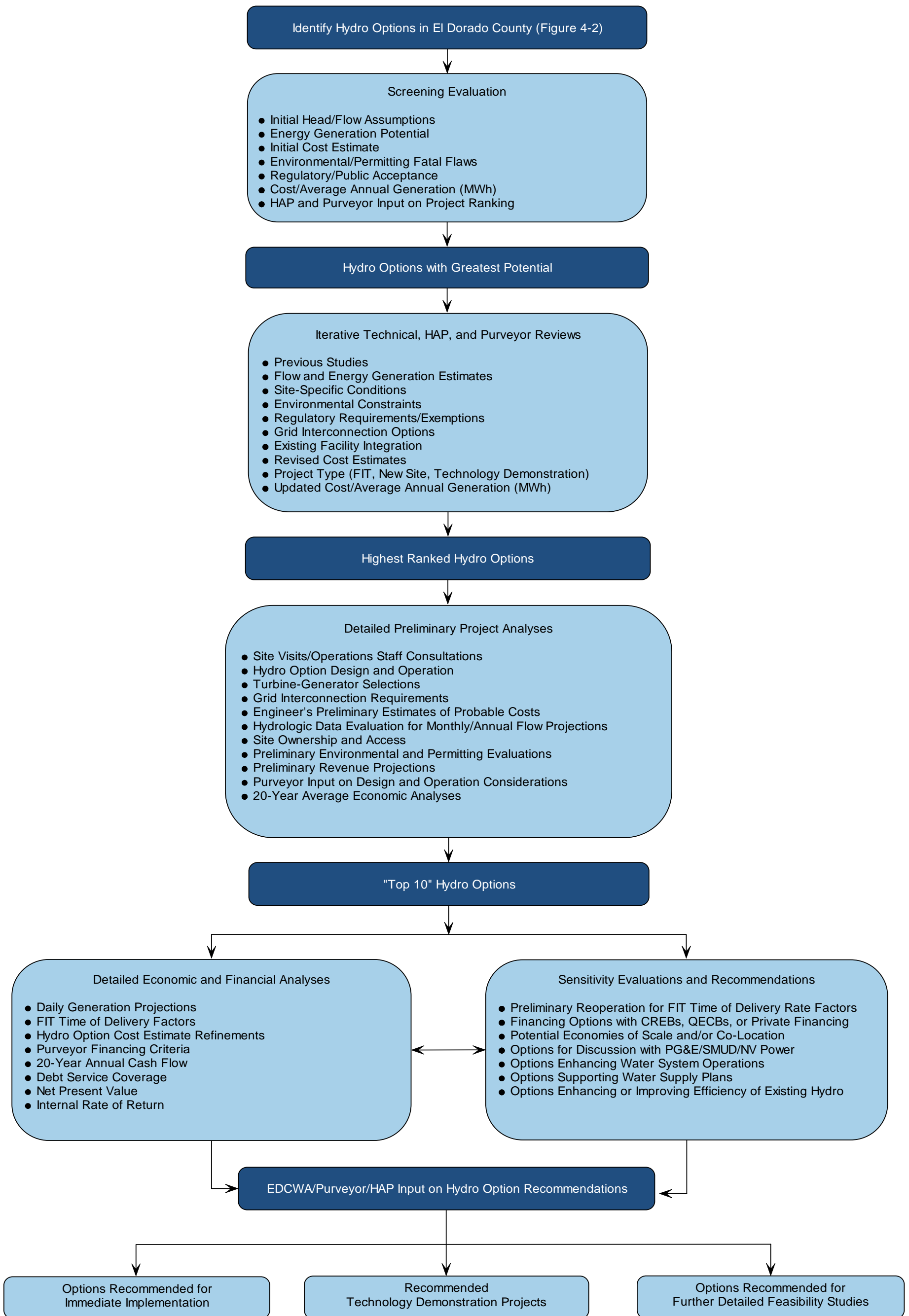
At this point, only one technology demonstration project had been identified as potentially viable. Renewed contacts with Verdant Power confirmed their continued interest to design and install a hydrokinetic demonstration project along the El Dorado Canal. Therefore, this project was automatically advanced as a technology demonstration project for further evaluation.

4.2.3 Hydro Options Advanced by Screening Evaluation

The screening evaluation process yielded a proposed ranking of all hydro options according to three tiers: 1) hydro options that were clearly superior to others in the same category based on the cost per average annual MWh, 2) hydro options that had higher costs per MWh, but which had other characteristics that warranted additional evaluation, and 3) hydro options that were clearly not cost effective based on hydroelectric generation, fatal flaw considerations, or other factors, and therefore did not warrant further consideration beyond the screening evaluation at this time.

The results and ranking of the hydro options from the screening evaluation were displayed in a comprehensive evaluation matrix (see Table 5-1 in Section 5, Inventory of County Hydroelectric Potential). The project options were segregated into three tiers of shading that corresponded to their potential feasibility. EDCWA, HAP and purveyor representatives reviewed and concurred with the tiering. The highest tier (no shading) represented projects that would be advanced for more project analyses. To assist with the selection of projects to be advanced for further analyses, the Consultant Team plotted average annual generation (abscissas) vs. estimated capital cost to construct (ordinates) to develop a “scatter plot” that visually compares projects. For ease of review, the scatter plot data was converted to tabular format and is presented in Table 6-1 in Section 6 (Preliminary Project Analyses of Highest Ranked Hydro Options). In general, hydro options that did not have critical flaws and that were about \$1,500 to \$2,000 or less per average annual MWh were considered superior to the other options and identified for project-specific analyses.

Figure 4-3: Hydro Option Technical Evaluation Process



Some changes were made to the ranking of projects after the scatter plots and matrix were completed based on newly acquired information. In some instances, the new information changed the anticipated feasibility of the hydro options. Furthermore, because the FIT options have substantially higher energy values with the CPUC MPR rates (see Section 4.1.1, Feed-In Tariff Options), and because the CPUC's MPR schedule increased FIT rates in December 2008 by about 15 to 30 percent over the prior year's rates, the HAP members and purveyors recommended emphasis on FIT projects. Meetings were then held with the HAP and purveyors in which concurrence was reached on a final set of options for project specific analyses.

At the conclusion of the screening evaluations, a short list of 19 hydro options were identified to advance for detailed project analyses, from which the "top 10" would be identified for further detailed economic and financial analyses. The short-listed 19 projects identified are described in Section 6 (Preliminary Project Analyses of Highest Ranked Hydro Options). As noted above, the hydrokinetic demonstration project on EID's El Dorado Canal had already been identified for further evaluation and was included in the 19 options to be advanced.

4.2.4 Detailed Project Analyses on Highest Ranked Options

The detailed project analyses on the short-listed 19 hydro options were performed in two stages. First, preliminary project analyses were completed and compiled into an early draft report that was reviewed by the EDCWA, HAP, and purveyor representatives. Second, based on meetings with the Project Team and oral and written comments received, the "top 10" of the short-listed 19 projects were identified, refined and analyzed to assess their financial merits in the draft of this Final Report.

The first series of detailed project analyses were based on engineering, operations, hydrologic and system operation modeling, energy generation projections, site inspections, environmental reviews, permitting, other regulatory requirements, and general economic analyses. The specific issues and criteria considered include those presented in Table 4-1.

The short-listed 19 project options were next analyzed by applying the average 20-year FIT (117.30/MWh) to the revenue streams projected from average annual generation. This "FIT-adjusted" revenue stream was compared to debt service and annual Operation and Maintenance (O&M) costs projected over the same 20-year period. An annual "net" revenue (or cost) was then calculated and reduced to a single figure representing average net revenue (or cost) over 20-year and 30-year financing periods. This number enabled comparison among the 19 projects and allowed the Consultant Team to discern the "top 10" best projects out of the short-listed 19. This analysis is presented in Section 6.

Table 4-1: Issues and Criteria Addressed in Project Analyses

Hydro Option Characteristics	
Project Category	Existing Facility, Existing Facility w/Reoperation, New Facility, Hydro w/ new water supply, Demonstration/New Technology
Operational Mode	Most likely operational mode (peaking, baseload, or as determined by water system demand)
Transmission Line Access (distance)	Distance from transmission facilities for interconnection; Accessibility to transmission facilities for connection to project site
Property Ownership	Owners and type of ownership (fee ownership by purveyor, private property, or government-owned property); ease or difficulty of acquiring land ownership to build project
Water Rights	Favorability of ownership of existing water rights or ease of transferability of water rights for proposed project needs
Access Right-of-Way	Project site accessibility for construction, equipment staging, and operation & maintenance
Design and Cost Criteria	
Head (ft)	Gross head of the hydroelectric project in feet
Flow (cfs)	Available flow through the hydroelectric project in cubic feet per second
Capacity (MW) and (AF)	Hydroelectric plant capacity in MW and firm annual yield of a water supply component in Acre-Feet
Flow Frequency	Permanent or intermittent flow available for hydro plant operations
Project Design and Construction Costs (\$/kW)	Site constructability and/or engineering design challenges considering location and existing facilities
O&M Cost (\$/kWh)	Project operation & maintenance challenges after project completion; annual and replacement cost
Flow, Energy, and Revenue Criteria	
Feed-In Tariff	Eligibility for FIT program or other incentive
Amount of Generation	Annual, seasonal, and diurnal generation based on flow data
Timing and Value of Generation (peaking factor)	Potential power marketing revenue that the project would produce; FIT rate multipliers for TOD
Water Supply	Water supply features of project
Environmental and Regulatory Criteria	
Resource Agency Coordination/Consultation	Resource and land management issues for permitting
Environmental Permitting and Review [National Environmental Policy Act (NEPA)/CEQA]	Eligibility for CEQA/NEPA exemptions; anticipated environmental review processes
FERC Exemption/Permitting	Eligibility for FERC exemption from licensing
CEC RPS Certification	Eligibility for RPS and FIT
Public Support	Public acceptability or anticipated support/objections
Recreation	Recreational benefits including instream flows
Habitat Enhancement	Opportunities for downstream aquatic resource and other environmental benefits

A primary refinement used on the “top 10” but not on the “short-listed 19” was the application of the FIT TOD energy values based on existing water system operations. Through the preliminary and final analyses, the effect of the time-of-day and time-of-year FIT rate multipliers (collectively, TOD) became evident. Instead of the average \$117.30/MWh 20-year rate that was assumed for the general economic analyses on the short-listed 19 hydro options, CPUC-approved TOD rate multipliers for PG&E’s standard FIT contract were applied in the detailed economic and financial analyses of the “top 10” projects. This is discussed in greater detail in Section 6.

Another refinement used in the economic analyses for the “top 10” projects was the preparation of annual cash flow projections over the 20-year analysis period. The financial spreadsheet model for the “top 10” produced estimates for key economic indicators including internal rate of return, debt service coverage, payback period, and net present value.

The economic and financial analyses for the projects were initially anticipated to address the possibility of private investment or ownership in the hydro options. However, the results of the analyses in Section 7 (Detailed Project Analyses of “Top Ten” Options) do not indicate a rate of return that would typically support the “hurdle” for private investments (i.e., 20 percent); private investor financing scenarios were therefore not completed.

The design, costs, hydrology, operations, energy, economic, financial, environmental, regulatory permitting, and other assumptions that were used for the detailed project analyses are described further in technical appendices to this Plan as follows:

- Appendix A – Project-Specific Cost Estimates and Technology and Design Considerations
- Appendix B – Hydrologic, Energy, and Economic/Financial Analyses and Assumptions
- Appendix C – Environmental Regulatory, Permitting, and RPS Certification and FIT Contract Requirements

Appendix A lists the unit costs assumed for the project cost estimates and includes a breakdown of the engineer’s preliminary estimate of probable costs by project. Project estimates include the cost of financing and operation and maintenance costs, including allowances for future equipment renewals and replacements. Appendix A also discusses the design options and operational issues that were considered in selecting the turbine-generators for the projects.

Appendix B presents the flow modeling and projections that were developed for estimating energy generation. This includes the assumptions for turbine generator efficiencies, projections for future water demand, and the time of day and time of year estimates that were applied for the FIT rate multiplier (TOD) factors. Using the projected energy values from Appendix B and the cost estimates from Appendix A, detailed financial analyses for each project were prepared, the results of which are also

presented in Appendix B. The financial analyses compare the project revenues and costs on an annual basis for a 20-year analysis period. The financial analyses are based on assumptions provided by EID that the projects would be funded using system funds, the most recent of which were 30-year bonds with an interest rate of 6 percent.

Appendix C describes the anticipated regulatory requirements for permitting, hydroelectric licensing and exemptions, environmental review processes and exemptions, and public consultations. This appendix describes the CEC RPS certification that is required for the hydro options to qualify for the standard PG&E FIT contracts and rates, including TOD multipliers. Copies of the PG&E standard FIT contract and an overview of the FIT program are also included in Appendix C.

The detailed economic and financial analyses were used to identify the economically viable projects, which are recommended for implementation as described in Section 9 (Recommendations and Next Steps). Because the projects recommended for immediate implementation all rely on the FIT program for viability, an important condition is that the project be online within 18 months of FIT contract execution. Assuming that FIT contracts are executed not later than November 2009 (December 2009 is when the FIT program likely will be revised, which is further discussed in Section 2), then the recommended projects will need to be online by May 2011 to receive the energy payments assumed in this report's economic analyses. Otherwise, PG&E has the discretion to re-queue the project and apply a new FIT contract and rates that are in effect following the expiration of the 18-month period.

The Project Team recommends further project evaluations that will be funded (EID 2009) through a grant received from the CEC under its Renewable-based Energy Secure Communities (RESCO) Public Interest Energy Research (PIER) program. This evaluation will identify the extent to which system re-operation would further benefit the economics of the recommended hydro options, and possibly make additional hydro options economically viable. System reoperation could include changing the TOD or flow-frequency of an existing water system, thereby taking advantage of peak pricing and shoulder peak pricing periods. Reoperation could further include the installation of additional storage tanks that could establish system-wide changes in the timing of flows through multiple in-conduit generators of the same system.