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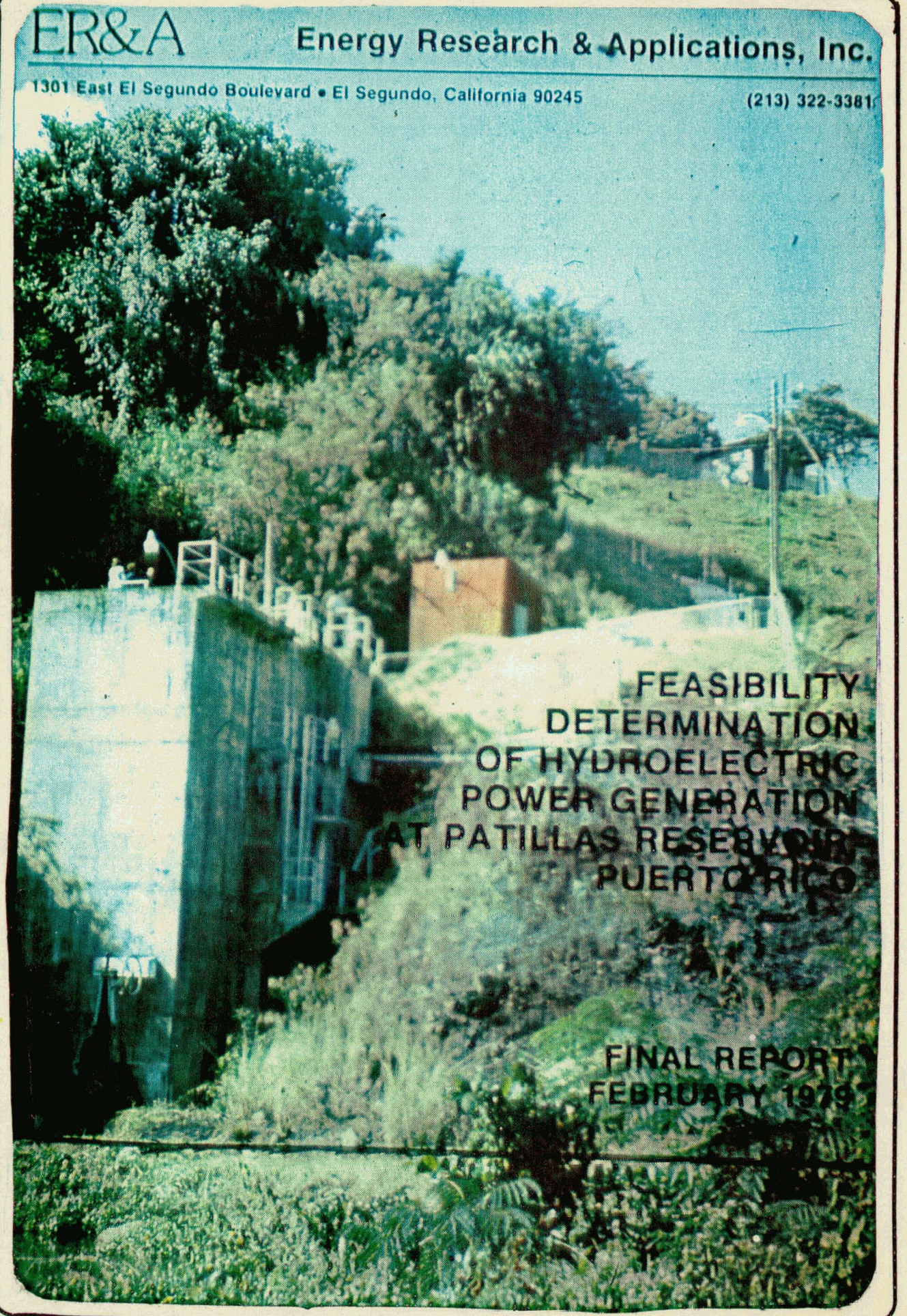
ER&A Energy Research & Applications, Inc.
1301 East El Segundo Boulevard • El Segundo, California 90245 (213) 322-3381



FEASIBILITY DETERMINATION OF HYDROELECTRIC POWER GENERATION AT PATILLAS RESERVOIR PUERTO RICO

FINAL REPORT
FEBRUARY 1979

DISCLAIMER

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FEBRUARY 1979

Submitted in Performance of

U.S. DEPT. of ENERGY AGREEMENT EW-78-F-07-1804

Project Manager:

John J. Huetter, Jr.

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1.0 DETERMINATION OF FEASIBILITY: HYDROPOWER RETROFIT AT PATILLAS RESERVOIR, PUERTO RICO

The objective of this study as contracted between ENERGY RESEARCH & APPLICATIONS, INC. and the U.S. Dept. of Energy, is to determine the overall feasibility of retrofit for hydroelectric power generation at the Patillas Reservoir, an existing impoundment located near the town of Patillas, Puerto Rico.

The scope of work and project intent is limited to establishing valid acceptance or non-acceptance criteria for this specific site as an example of power generation potential at existing dams of relatively low head ($\leq$ 20m) in the United States.

Determination of the hydropower resource potential of the island or its place in a mixed alternative energy future for Puerto Rico are outside the scope of this contract.

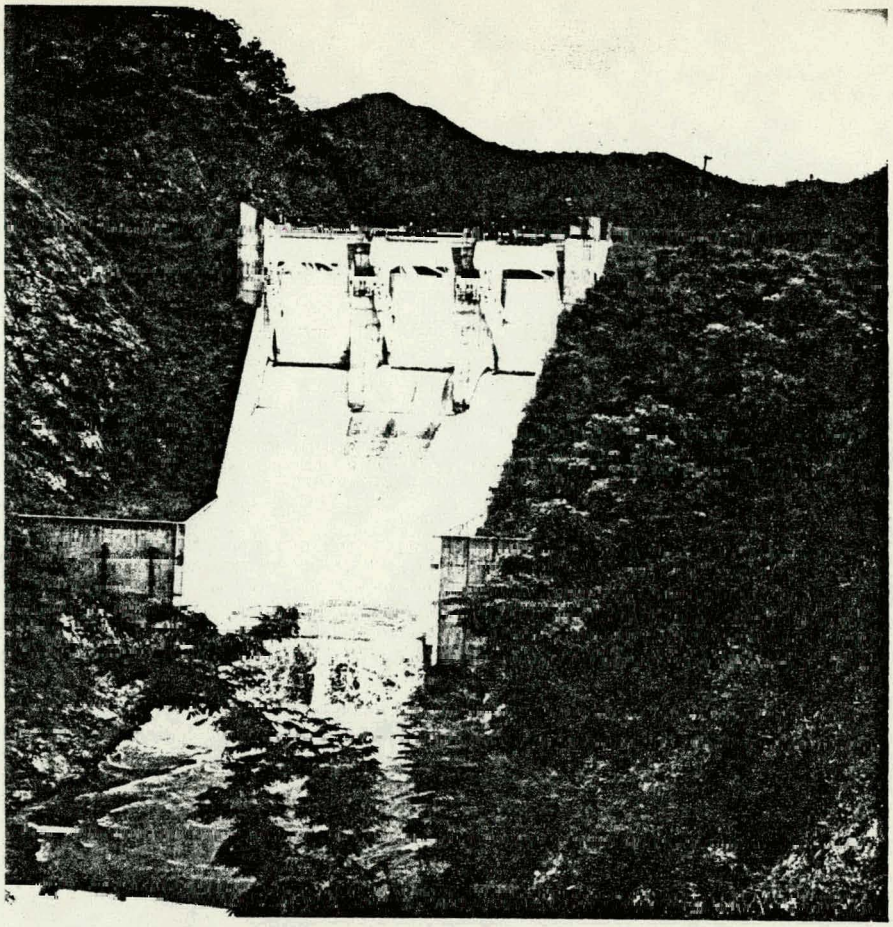
Where reasonable judgments can be made or factors affecting Puerto Rico's overall energy supply and consumption patterns identified as pertinent to this effort, they have been addressed.

It is ER&A's intent in this effort to develop a suitable methodology for hydropower feasibility determination at any existing dam/reservoir in Puerto Rico. Application of the analytical techniques herein developed on a site-specific basis should provide a clearer picture of the island's recoverable hydroelectric power resource and effects on oil imports.

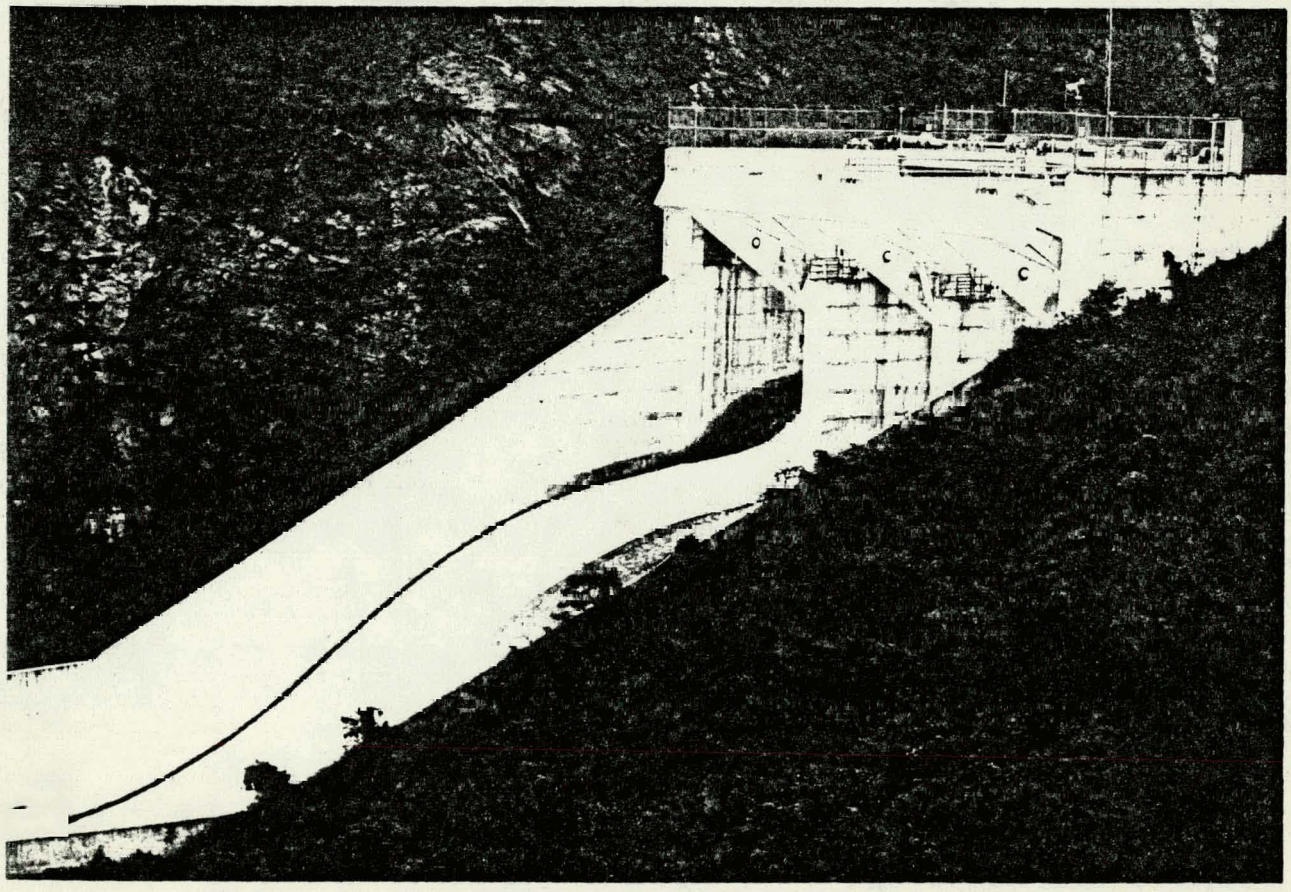
This section contains two categories of factors determining the retrofit of hydropower generating facilities to the Patillas Reservoir in Puerto Rico. They are generically classified as:

1) Roles and relationships of agencies and other actors involved in this feasibility project.

2) Summary conclusions as to the multi-level feasibility of hydropower generation at the Patillas reservoir and irrigation system, including a schedule for implementation.



Two views of the spillway at Lago Patillas, Puerto Rico, object of this study.



The ultimate conclusion of this feasibility determination is that generation of hydropower at Patillas is entirely practical and uncomplicated from an engineering viewpoint, has no adverse environmental effects and is economically justifiable for the island of Puerto Rico. The final agency or contractor roles for development are reasonably well-established. There are no prohibitory laws or regulations concerning this development. In fact, according to Puerto Rico legislation, such hydropower developments appear to be mandated.

The installed capacity of the site ranges from 665KW to approximately 1500KW depending on extent of development of the available options.

1.1 Agency Roles and Relationships

Puerto Rico Water Resources Authority (Autoridad de las Fuentes Fluvioles-AFF) - the sole electrical and water resources utility on the island. Controls and operates all electric power generating sources and the transmission and distribution grid. Functions as an unregulated, untaxed, public corporation which is, in practice, an instrumentality of the government of Puerto Rico. The AFF is the single largest structure and employer in Puerto Rico. AFF detailed comment on the Interim Report for this effort is included as an Appendix.

Puerto Rico Office of Energy - a division of the Office of the Governor created to establish and implement Puerto Rico's energy policy in all areas from oil imports to possible gasoline rationing. The Energy Office is a relatively new agency (est. October 1977) which is taking its state energy plan to public and legislative hearings as this study is being completed. They have identified and are proponents of renewable energy resources as part of the necessary future of Puerto Rico. The Office of Energy served a key role in identifying specific contacts within affected state agencies and coordinating the activities of the prime contractor with these agencies in a productive and timely manner.

1.1 Agency Roles and Relationships(cont'd)

Center for Energy and Environment Research - formerly the Center for Nuclear Studies of the University of Puerto Rico, the CEER reflects an expanded notion of the appropriate role for a university - affiliated research institute. The CEER was sub-contracted through Dr. William Jobin, Head of the Human Ecology Division, to provide ecological descriptions of the Patillas Reservoir and effects of the proposed hydropower retrofit. Dr. Jobin and Dr. Modesto Iriarte, a consultant to the CEER, reviewed the project Interim Report and commented on their views of progress at that time as well as local considerations.

The earth dam at Lago Patillas, site of the diversion to the open channel irrigation canal, is also the site of the primary option powerhouse installation for hydropower development as identified by the study team. Ready access to the power grid is available, as shown in this photo.

1.1 Agency Roles and Relationships(cont'd)

ENERGY RESEARCH & APPLICATIONS, INC. - prime contractor to the U.S. Dept. of Energy for completion of a hydropower retrofit feasibility study at Patillas, Puerto Rico. ER&A is an independent small business devoted to alternative energy resources and conservation technology.

U. S. Dept. of Energy, Idaho Operations Office - contract financial and technical monitor of the nationwide hydropower feasibility program for DOE.

1.2 Summary Conclusions by area of investigation

Detailed hydrologic investigation, including computer analysis of 59 years of reservoir behavior, indicates that significant amounts of energy can be recovered through hydropower retrofit at Patillas. From a pure hydrologic standpoint, up to 800 kW of peaking power or 400 kW of base load power are available from one installation. This first level analysis does not take engineering or other restrictions into account. The hyrology at Patillas also indicates that additional power may be gained during the "wet" season by using reservoir surplus flows (above commitment) during approximately seven (7) months at an additional installation.

In the engineering feasibility determination, multiple retrofit design options were developed and evaluated. After technical consideration and consultation as to impact were completed, three distinct phases of potential hydropower development were identified for the Patillas site. Phase I consists of the addition of power generating equipment to the existing irrigation water outlet structure at the large earth dam. A range of suitable hardware was identified and head limitation indicates the maximum installed capacity to be 665 kW as a mechanical reality.

Phase II involves the construction of a penstock and power house adjacent to the rebuilt concrete spillway. This installation will displace some spillage requirements but discharge

tailwater into the natural streambed as does the spillway now. When used to provide peak power, in addition to the Phase I installation, installed capacity is rated at 650 kW. It would be expected to operate approximately seven months a year as indicated by hydrological feasibility.

Phase III consists of a power plant added to the irrigation canal over a mile downstream from the dam where flow transitions from open to closed channel. While not considered an economically attractive option at this time, it is a straightforward engineering exercise and identified as a future possibility. Firm power production is calculated at 300 kW.

Fully automatic operation is feasible for all phases of hydropower retrofit and is therefore costed, assumed in design, and recommended. All required technology is available for dependable, remote operation at justifiable cost.

Due to the particular role of the Puerto Rico Water Resources Authority, the viewpoint selected for determining economic feasibility of the Patillas project is that of Puerto Rico. The supporting rationale for this level of analysis are developed in detail in Section 4. Basic to it is $14/Bbl oil as the basis of Puerto Rico electric power capacity.

A model structured on critical or impact factors with output consisting of costs and benefits of the project, as well as ROI, was developed for use in the Puerto Rico environment. (Appropriate tax assumptions, etc. are constant and imbedded in the analytic tool.) This approach allows for an independent assessment of economic viability. The responsible entity can operate the model and determine if resulting return on investment, cost/kW, oil savings, or other decision factors meet required thresholds. The calculated ROIs of varying installation phases and modes of operation range from 8.3% to 21.8%. The most

attractive operating strategies focus on displacing the maximum amount of imported OPEC oil.

One of the directives established for determining engineering feasibility of the Patillas project was to minimize environmental impact and ecological disruption.

The determination has been made by both ER & A staff ecologist and the Puerto Rico Center for Energy and Environment Research, under subcontract, that the proposed method of retrofit substantially satisfies that goal. No ecological effects over and above those already created by reservoir use and irrigation demands will be created by hydropower generation at Patillas.

Transient environmental disruption during construction is expected to be minimal and identifiable in detail.

Personal interviews with responsible Puerto Rico agencies including the Environmental Quality Board further reinforce the scientific finding that there will be no environmental prohibitions to the implementation of this hydropower project.

Installation and utilization of proposed retrofit of hydropower generating capacity at the Patillas site is feasible from the legal and regulatory viewpoint.

Hydroelectric development of the Patillas Reservoir waters is specifically authorized by Puerto Rican law and the Water Resources Authority has legal authority and responsibility to undertake such a project. Neither previously dedicated water flows nor water rights of downstream users will be affected.

FERC licensing is not required. Even if it were required, the Patillas project would be exempt under newly enacted Section 30 of the Federal Power Act.

Approval by the Puerto Rico Planning Board, Environmental Quality Board, and Regulation and Permits Administration

is required. Prompt approval is anticipated based on information transmitted to ER&A by said agencies in the course of this investigation.

A list of over 20 potential turbogenerator hardware suppliers has been narrowed down to four vendors who were responsive with detailed equipment lists, cost quotes and delivery schedules. The engineering design was executed in a manner that will permit the use of equipment from any vendor identified.

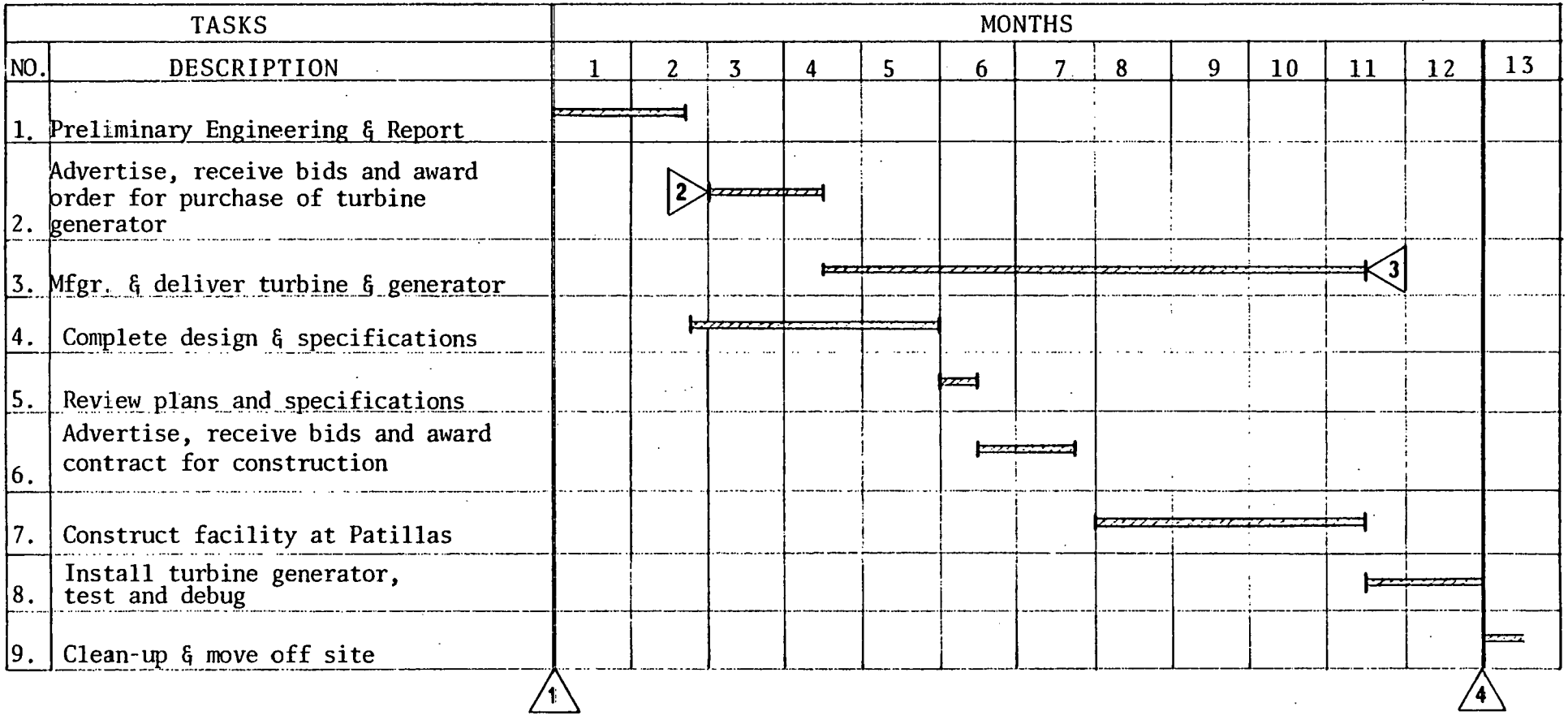
Basic equipment costs ranged from approximately $190,000 to $335,000 including automatic control, interfacing and switching hardware.

The primary institutional factor encountered was the fact that the Water Resources Authority had been retiring previously installed hydropower sites. It was therefore a more complicated procedure to explain and justify why it made sense to develop new hydropower capacity at existing, unused impoundments. The benefits of displacing oil and gas-based power with a renewable indigenous resource had to be clearly developed and various decision-makers so persuaded.

There was also the question of size. Why should a 4000MW grid care about another half megawatt of installed capacity? The political, economic and social benefits of any increased measure of energy source independence from OPEC oil had to be addressed.

The nature of the Patillas site as an exemplary case for the re-development of abandoned and new hydropower sites was also emphasized along with this resource's potential in a mixed energy futures strategy for the entire island of Puerto Rico.

TABLE 1.1 IMPLEMENTATION SCHEDULE - DESIGN & CONSTRUCTION OF HYDROPOWER PLANT IN EXISTING PATILLAS EARTH DAM IRRIGATION OUTLET STRUCTURE



1. Award of contract for engineering design services & notice to proceed.
2. Make decision re: type of turbine based on preliminary engineering report & recommendation.
3. Turbine and generator delivered to job site.
4. Contract complete, turbo generator on line.

VIEW OF LAGO PATILLAS FROM THE SITE OF THE EARTH DAM,
APPROXIMATELY ONE MONTH INTO THE DRY (DRAWDOWN) SEASON

2.0 HYDROLOGIC ANALYSIS FOR HYDROPOWER FEASIBILITY DETERMINATION

The Patillas Dam and Reservoir are located on the Rio Grande de Patillas in Puerto Rico. The Patillas dam is an earth dam, about 147 feet high from the valley floor and 1020 feet long with a crest elevation of 237 feet above the mean sea level. The Patillas reservoir system controls a drainage area of approximately 25.5 sq. miles, with an annual average rainfall of about 80 inches. The storage capacity of the Patillas reservoir at the spillway crest has been raised from 12800 AF to 14300 AF. This has been done by raising the spillway crest twice. Water supply for irrigation from the reservoir is carried by a 25 mile long canal with an average daily flow of 70cfs to 105cfs depending upon the demand level. The reservoir has a surface area of 0.5 square miles. The reservoir is fed by two streams, the Rio Grande de Patillas with a contributing drainage area of 19.8 sq. miles and the Rio Marin with a contributing area of 5.7 sq. miles.

An automatic water level recorder was installed in November 1965 on Rio Grande de Patillas upstream of the Patillas reservoir. Data from the automatic recorder was not available for this study. However, monthly streamflow records were available from 1908 to 1969, and served as the baseline data for this analysis.

2.1 Hydrologic Data and Physical Characteristics

Table 2.1 shows the runoff of the streams entering the Patillas reservoir. Records from 1967 - 1969(the last 3 years) were not used in the analysis since water was diverted from the reservoir in 1967 to allow some construction work at the reservoir site. Thus, a total of 59 years of records (1908-1966) were used to perform the hydrologic analysis. This span covers a wide range of reservoir uses including cane irrigation. It is assumed that 59 years of records, or 708 monthly time periods, are sufficient to quantify the statistical variability of the streamflow. Table 2.2 shows the monthly total hours, the corresponding on-peak hours, and variation in demand. On-peak hours are from 7 a.m. to 7 p.m., Monday through Friday. The 1979 calendar year was used

PUERTO RICO WATER RESOURCES AUTHORITY RECORDED DATA

TABLE 2.1A

RUNOFF OF THE STREAMS ENTERING PATILLAS RESERVOIR
(ACRE FEET)

Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Total
1907										4245	2350	3765	(10360)
1908	3690	5511	4612	2129	3533	4240	6707	7472	15555	12216	4687	4804	75156
1909	10222	4640	2455	1810	14330	11179	7329	22186	12384	11770	21215	3230	122758
1910	2478	1732	3105	1477	2064	2862	3044	9212	11276	6966	3847	3524	51187
1911	2696	5002	1426	1720	9460	6169	5425	5398	6466	8020	6743	10200	68725
1912	7467	3708	5079	3833	2472	5414	2739	2816	4386	21307	14555	4196	78002
1913	6684	3904	8484	5335	7047	9601	9507	7022	9189	6925	6251	2607	82556
1914	2093	6958	2700	3475	8487	8249	5066	4968	4097	2812	12331	5057	66293
1915	4796	3603	2027	2344	1539	12582	8034	4931	5488	3666	2331	3669	55010
1916	1681	1192	992	898	1813	4006	13470	14608	8453	21213	28883	3655	100964
1917	1707	1042	863	889	2013	3835	5459	5709	6374	4095	3521	4620	40127
1918	1755	1610	1099	1119	1874	6395	5228	1996	9095	14741	13249	3786	61947
1919	4436	1393	848	2981	4360	11980	14991	4980	7047	7831	2917	7634	71398
1920	4461	15667	17778	1991	3214	2335	7430	6614	3305	3088	6786	5942	78611
1921	7852	4056	5530	3257	2033	5139	10317	5884	7092	9748	8364	3435	72707
1922	2166	3245	3843	1667	3082	7586	4773	6395	8385	11740	2397	8871	64150
1923	2019	1832	1455	3028	1304	4844	3289	4663	6742	7611	3028	1516	41331
1924	2272	4455	1699	990	3135	4780	11203	14104	10259	6356	25959	4243	89455
1925	4192	2147	1504	2176	3197	4677	4253	5780	5474	3314	7330	3047	47091
1926	2199	2125	1493	1643	3487	3117	13825	7952	4384	5124	4167	1475	50991
1927	1790	1090	2847	1450	3194	6012	9043	6224	3130	6801	9408	2604	53593
1928	1598	1562	1272	966	5008	1681	4212	6452	13426	5222	5004	5913	52316
1929	6792	2219	4457	1459	9437	7228	4514	7405	5624	5223	4780	4678	63816
1930	8190	3690	2022	2079	2654	4085	2830	2505	3027	2651	2625	1470	37828

(3)

PUERTO RICO WATER RESOURCES AUTHORITY RECORDED DATA

TABLE 2.1 B

RUNOFF OF THE STREAMS ENTERING PATILLAS RESERVOIR
(ACRE FEET)

Year	15 Jan	21 Feb	27 Mar	33 Apr	39 May	45 June	51 Jul	57 Aug	63 Sept	69 Oct	75 Nov	81 Dec	Total
[illegible]	1113	2546	875	3242	17520	13867	8863	7277	7056	7044	10158	5248	84809
[illegible]	3298	1790	1452	1168	11345	8104	6037	5386	5000	4404	11528	4323	63935
[illegible]	3068	1364	2012	1287	9459	7849	7174	5736	8859	7470	5467	4244	63989
[illegible]	3197	1578	1614	1471	3505	3570	7230	7785	5257	2355	1821	6826	46209
[illegible]	2741	5202	1273	798	2312	2504	4058	6860	7828	6109	2043	2771	44499
[illegible]	1240	642	675	585	17971	10775	9705	11973	11630	10341	9770	3351	88558
[illegible]	12339	2567	1515	2497	1796	1254	661	5960	3229	3869	7567	6548	49902
[illegible]	1453	1383	741	365	2410	11116	3376	2900	6264	4353	10818	5817	50996
[illegible]	2409	1399	1314	1522	3642	2908	2495	1694	4860	2861	5552	2212	32868
[illegible]	1199	1626	1193	813	6334	5323	5848	2442	3552	8364	5622	4484	46600
[illegible]	3557	1639	784	1041	3300	5010	9740	3512	5022	2339	2996	4919	43859
[illegible]	4636	2859	1122	6486	1753	8824	6773	6194	4270	4601	4880	2994	55392
[illegible]	5087	2145	1938	7530	12600	6354	4263	6170	4578	6361	2772	1701	61499
[illegible]	872	1018	337	489	5053	12319	7341	5508	7665	6194	2578	1674	51043
[illegible]	1139	834	770	3919	8143	2713	4352	15098	5150	3344	1893	2812	50167
[illegible]	2012	2555	1103	868	8462	7214	2094	2807	7911	10885	4219	3147	53277
[illegible]	3947	2108	1212	1038	6207	5976	2078	1457	5260	3425	2174	1128	36010
[illegible]	1643	1006	892	553	6132	7099	12310	8027	7587	5947	14596	8827	74619
[illegible]	2149	1226	1923	1132	8070	9552	8644	6679	13933	8247	4628	3024	69207
[illegible]	3071	5570	1991	4872	4804	4352	4053	5910	3723	9028	8045	1883	57302

PUERTO RICO WATER RESOURCES AUTHORITY RECORDED DATA

TABLE 2.1 C

RUNOFF OF THE STREAMS ENTERING PATILLAS RESERVOIR
(ACRE FEET)

Year	15 Jan	21 Feb	27 Mar	33 Apr	39 May	45 June	51 Jul	57 Aug	63 Sept	69 Oct	75 Nov	81 Dec	Total
1951	2305	995	634	859	6474	8932	8838	5522	9529	7606	3731	2491	57916
1952	2833	1752	1089	1943	6146	5065	10337	5252	16132	7278	4846	1832	64505
1953	1905	930	694	552	1143	5636	6889	7376	10335	5131	3580	4955	49126
1954	2465	4815	2208	1611	3813	5277	5643	5239	23758	16977	4177	2692	78675
1955	1798	1617	1252	1120	831	6354	3083	4975	5542	5229	4487	2976	39264
1956	1754	5678	1364	2102	4548	8179	2793	7938	4348	7560	5183	4559	56306
1957	2612	2215	1308	1153	1505	9860	3326	5508	3847	4412	2887	6554	45217
1958	3815	1756	1074	1903	9472	9802	15615	3914	4018	4520	4539	3274	63702
1959	2432	2154	1445	2018	8207	4813	5548	4217	2522	4481	2576	4403	44816
1960	2031	1446	2395	5366	4290	7655	4380	11798	15735	5784	7120	11719	79719
1961	2347	1507	930	2979	5750	6103	10777	18306	5404	7346	4171	6005	71625
1962	4974	2884	1484	3246	5976	7998	5220	12990	4387	6627	3591	2099	64475
1963	2137	1969	1407	2700	5928	5512	4449	7997	5583	3933	3419	2117	47151
1964	2973	1143	1233	1714	1618	5100	8004	4020	5153	4845	1757	1210	38775
1965	980	659	673	894	2915	8204	5340	9831	4947	3325	4558	4139	46165
1966	2573	1215	1344	1463	7932	5616	8317	5702	5294	6561	2596	2068	50681
1967	1347	995	979	889	1169	1485	1597	1830	811	1069	1348	580	14102
1968	1674	669	479	559	1029	7363	4312	789	3267	965	2489	402	23997
1969	435	907	1615	952	10234	2970	4332	3872	5462	2607	4692	2433	40511
Total	196826	158754	125933	124415	328535	396903	398583	411757	435366	416490	393202	248382	
Average	3175	2561	2031	2007	5299	6402	6429	6641	7022	6611	6241	3943	58362

DRAINAGE AREA - 25.20 SQUARE MILES.

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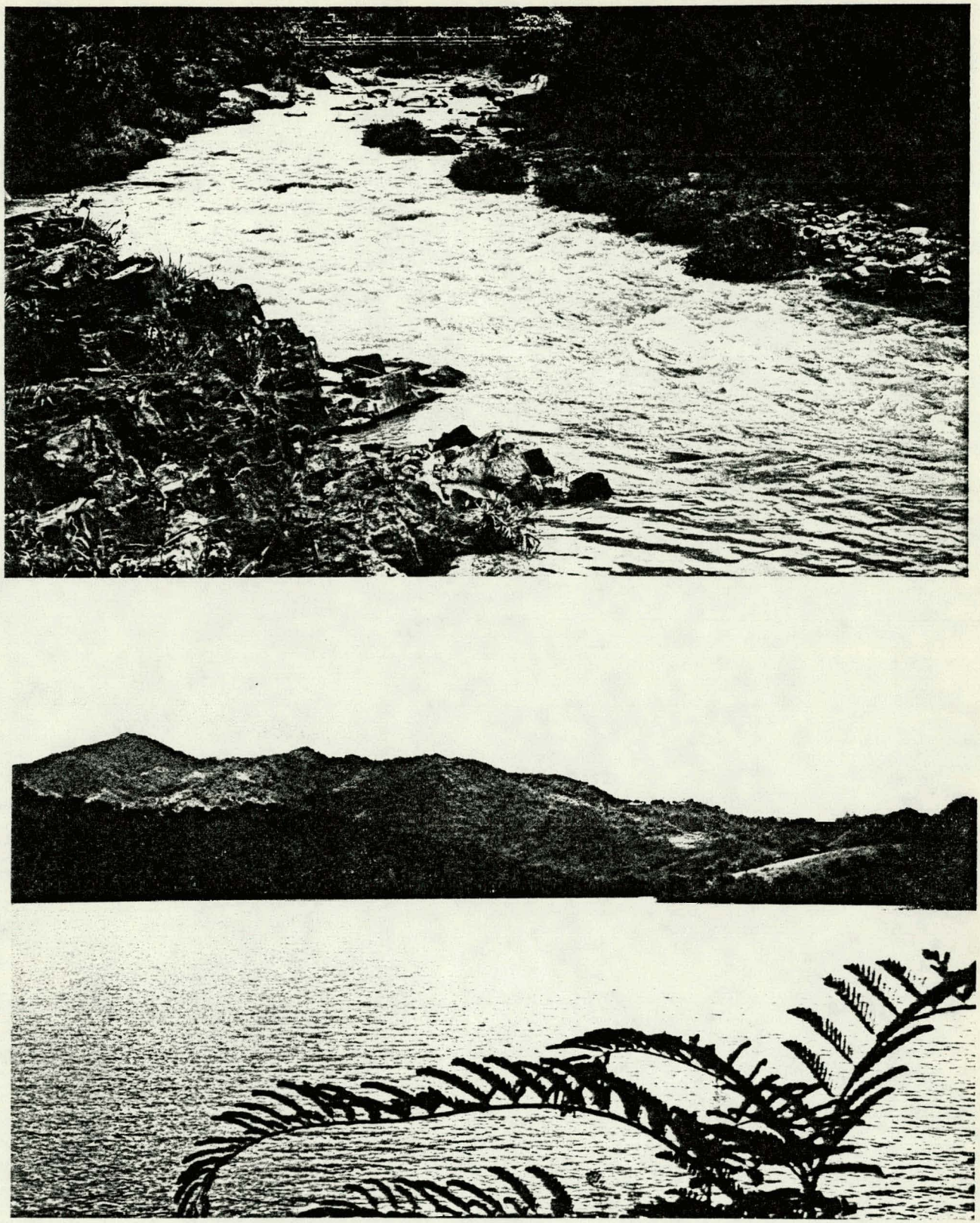


During the wet season, streams flowing into Lago Patillas from the watershed upstream fill the impoundment to its highest level.

in this study. On-peak hours represent the number of hours during which the hydroelectricity is generated for peaking purposes. At this stage of feasibility determination, it has not been established if the Patillas site will be used to displace thermally generated base load or as firm power for peaking purposes. Therefore, two alternatives are presented:

1) On-peaking generation based upon Table 2.2
2) 24-hour continuous generation

TABLE 2.2 VARIATION IN DEMAND

Monthly j	Monthly Total Hours	Monthly On-Peak Hours	Firm Energy Coefficient β_j	Mandatory Releases (AF)	Existing Water Right(AF)
January	744	276	.088	888	327
February	672	240	.077	2473	327
March	744	264	.085	2709	327
April	720	252	.081	1920	327
May	744	276	.088	1370	327
June	720	252	.081	2988	327
July	744	264	.085	1382	327
August	744	276	.088	1059	327
September	720	240	.077	234	327
October	744	276	.088	336	327
November	720	252	.081	838	327
December	744	252	.081	398	327
Summation	8,760	3120	1.00	16,594	3,925

NOTE: $\beta_j = \frac{\text{(Monthly on-peak hours)}}{\text{Total yearly on-peak hours}}$

2.2 Method of Determining the Firm Power Output of Reservoir

The historical monthly inflows are routed through the Patillas reservoir. Installed capacity and firm power output are parametrically varied. Results will be used for the determination of the installed capacity, firm power output, and the corresponding annual electricity yield. Power generated at a hydroelectric power plant is expressed as:

$$P = \frac{Qhe}{11.8},$$

where P = power production in kilowatts
Q = flow through turbine in cfs,
h = head on the turbine in feet
e = efficiency

The basic equation used in reservoir routing is the continuity equation,

$$S_{i+1} = S_i + I_i - R_i \quad [\beta_j \cdot FP, \; R_{man_j}],$$

$i = 1,2,3,\text{-----}N$ and $j = 1,2,3,\text{--},12,1,2,3,\text{--}\ 12,\text{---},$

where S_i = storage level at the beginning of period i,

S_{i+1} = storage level at the end of period i,

R_i = release necessary to produce the power level ($\beta_j \cdot FP$) or to meet the mandatory release in period i,

β_j = portion of the FP level which is to be delivered in month j,

I_i = inflow in period i less the local right

FP = annual firm power level in KW
i = time period that runs from 1 to total # of month,
j = monthly time period that runs from 1 to 12 and repeats

Evaporation loss is insignificant and is ignored.

The routing is subject to:

$$S_{min} \leq S_{i+1} \leq S_{max},$$

where S_{max} = maximum storage and

S_{min} = minimum storage

For a given initial storage (it is assumed full, since reservoir spills frequently), a given installed capacity, and a given firm power level, the continuity equation is carried out. The required

2.2 Method of Determining the Firm Power Output of Reservoir(cont'd)

release at any given time period is the maximum of:

1) the mandatory release for irrigation
2) the release necessary to produce the required firm energy, which is a function of the firm power level and number of on-peak hours

Water is always released through the turbine until it is limited by the installed capacity. The release required to produce the firm power is computed by the following equation:

$$R_i = \frac{(\text{Firm Power, in KW}) .550 \cdot 1.341}{\gamma \cdot h \cdot e}$$

where R_i = release in cfs,

γ = specific weight of water, 62.4 lb/ft^3, and

e = efficiency = 0.9

The value of R_i is converted from cfs to AF by the following formula

$$V(AF) = R_i(cfs) \times (\text{on-peak hours per month}) \times 3600(sec/hr) \times \frac{1}{43560} \left(AF/ft^3\right)$$

This value is checked against the release for irrigation and the largest value between the two is added to release for meeting the existing water right. Note that the release used for meeting the existing water rights is not available either for irrigation or hydropower production.

In order to compute the required release that will produce the required firm energy, iterations are necessary since head is a function of the average storage. Note that firm energy is equal to the product of firm power and number of on-peak hours. It is assumed that ending storage is equal to the beginning storage while average storage is computed. After the release has been determined, the continuity equation is resolved using the computed release. Ending storage is re-determined. The process is repeated until convergence is achieved. It was found that only 2 to 3

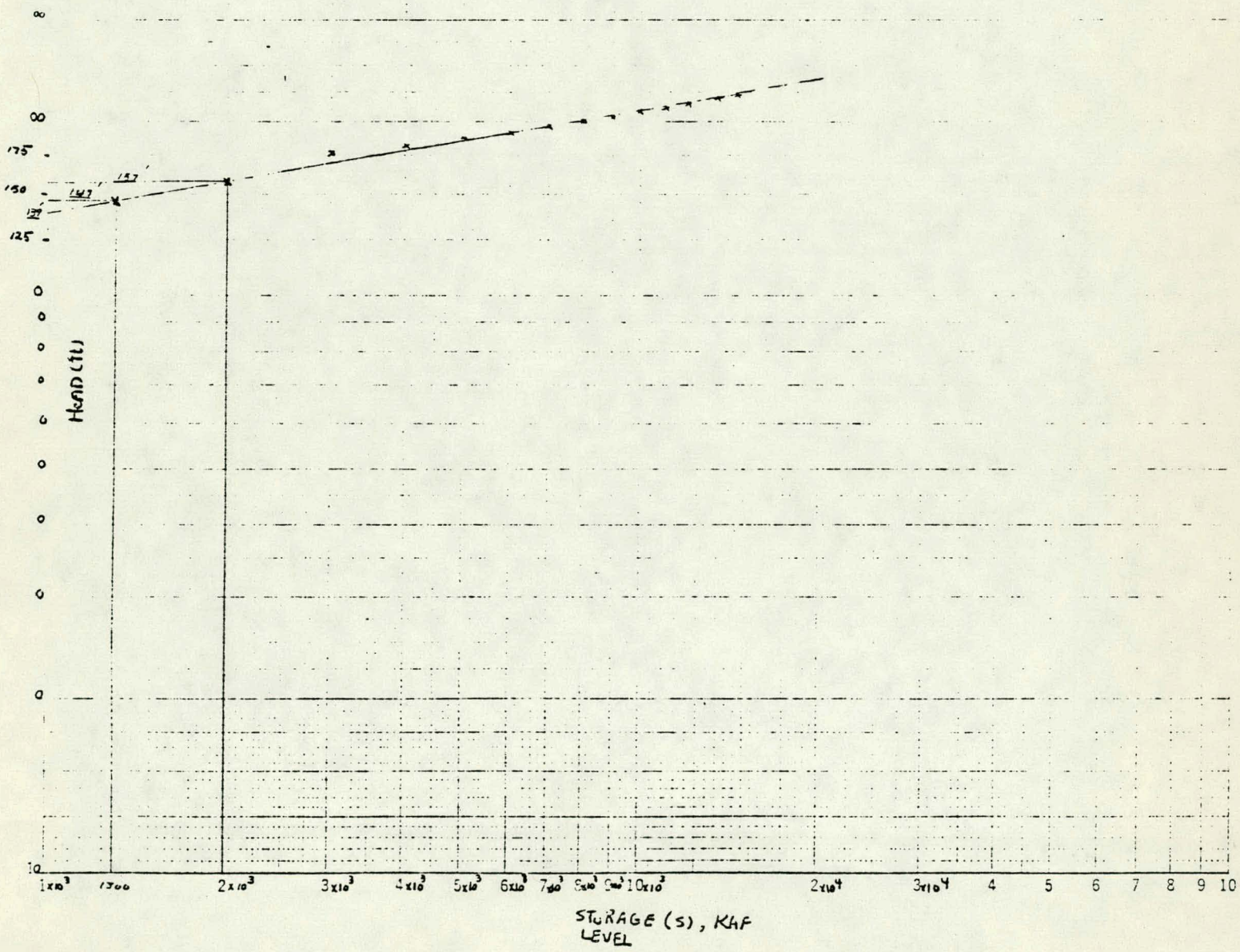
iterations were required by the computer program. During the process of routing, if the ending storage becomes less than the minimum storage (S_{min}) it is considered that failure has occurred in terms of meeting the firm power level requirement. The computer program prints out the number of times(months) that the system failed to deliver the specified firm power level. The probability of failure is computed by dividing the number of failures by the total number of time periods, therefore allowing the decision-maker to access the reliability of a given firm power level. On the other hand, spill will occur when S_{i+1} becomes greater than S_{max} and the amount of spill is also computed by the computer program.

Figure 2.1 shows the head and storage relationship. As expected, it is almost linear on a log-log plot. Values of head are in terms of elevations above the mean sea level. The base elevation at the reservoir site for turbine installation is 122 ft. above the mean sea level(MSL). Active storage in terms of water surface elevations is from 187'(MSL) to 222'(MSL). Therefore, the absolute gross head upon the turbine would vary from 48' to 82'.

For a given installed capacity, firm power level is varied from the maximum(which corresponds to the installed capacity) to some minimum level and hence a number of routings are required. The installed capacity is also parametrically varied. The final results would be a table that will show different combinations of the installed capacity, the corresponding firm power levels, annual electricity yield, and the associated reliability.

(12)

Figure 2.1: HEAD VS STORAGE LEVEL
PATILLAS RESERVOIR

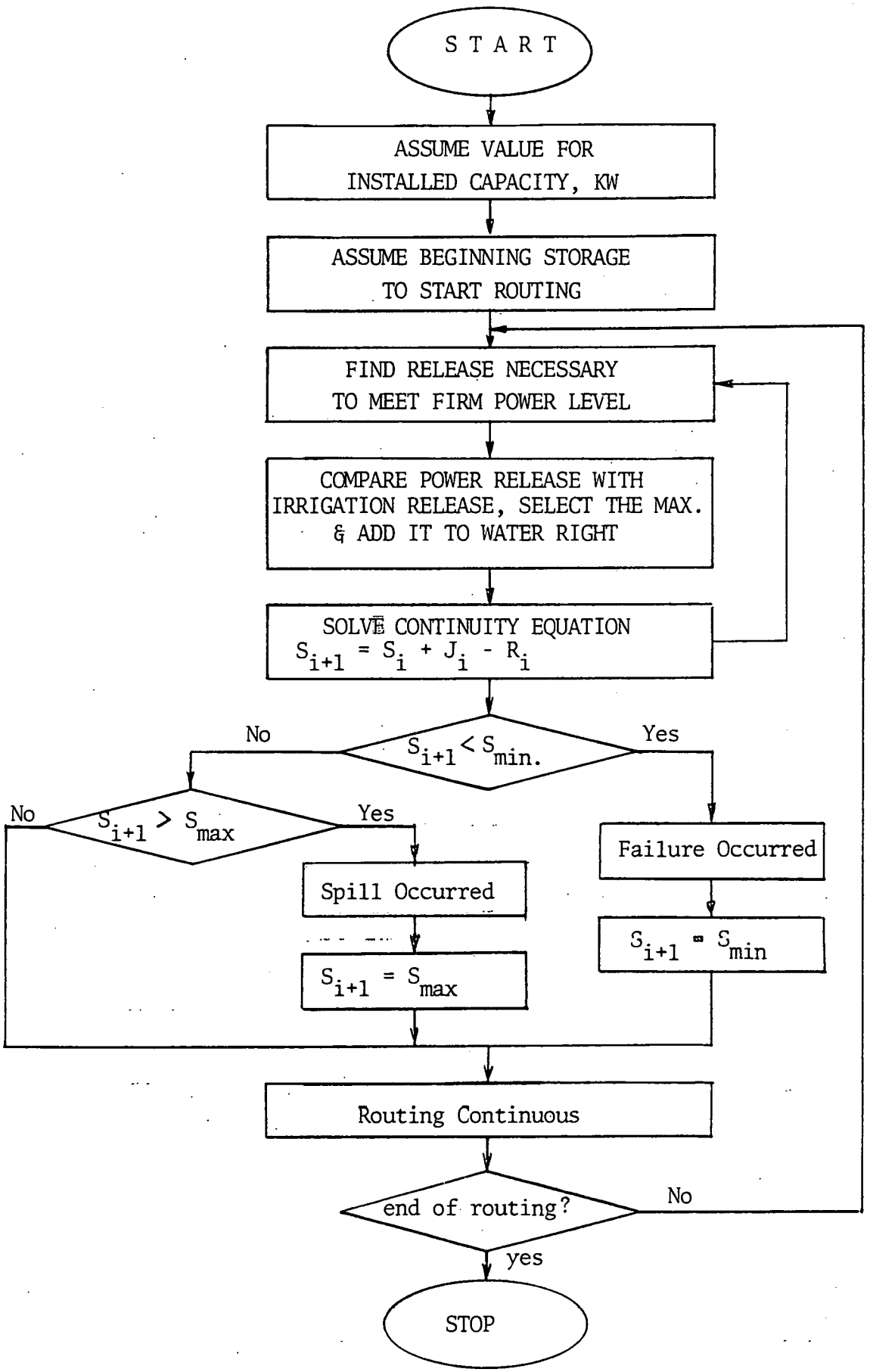


Logarithmic, 2 x 2 Cycles

2.3 Computer Program

A computer program was written to perform the foregoing routing and computations. A flowchart of the computer program is presented in Figure 2.2. Tables 3 and 4 show some sample outputs. The computer program, written in FORTRAN IV and operated on an IBM 360/91 machine, is available for review but is not included here due to bulk.

FIGURE 2.2 FLOW CHART OF HYDROLOGIC ANALYSIS PROGRAM FOR HYDROPOWER FEASIBILITY STUDY



INSTALLED CAPACITY 800.00 KW

TABLE 2.3 – ON-PEAK GENERATION

(12 hrs/day, 5 days/week)

FAILURES EACH MONTH

(throughout 59-year streamflow record)

KWH/H	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0	0	0	0	0	0	0	0	0	0	0	0
80.00	0	0	0	0	0	0	0	0	0	0	0	0
160.00	0	0	0	0	0	0	0	0	0	0	0	0
240.00	0	0	0	0	0	0	0	0	0	0	0	0
320.00	0	0	0	0	0	0	0	0	0	0	0	0
400.00	0	0	0	0	0	0	0	0	0	0	0	0
480.00	0	0	0	0	0	0	0	0	0	0	0	0
560.00	0	0	0	0	0	0	0	0	0	0	0	0
640.00	0	0	0	0	0	0	0	0	0	0	0	0
720.00	0	0	0	0	0	0	0	0	0	0	0	0
800.00	0	0	0	0	0	0	0	0	0	0	0	0

SPILL EACH MONTH (NUMBER OF INCIDENTS IN 59-YEAR RECORD)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	54	18	7	8	32	42	52	58	59	59	59	59
249.60	54	18	7	8	32	42	52	58	59	59	59	59
499.20	54	18	7	8	32	42	52	58	59	59	59	59
748.80	54	18	7	8	32	42	52	58	59	59	59	59
998.40	54	18	7	8	32	42	52	58	59	59	59	59
1248.00	54	18	7	8	32	42	52	58	59	59	59	58
1497.60	53	18	7	8	31	41	52	57	59	59	59	57
1747.20	51	18	7	8	31	41	52	56	59	59	59	57
1996.80	45	18	7	8	30	41	52	56	59	59	59	54
2246.40	43	18	7	8	30	40	51	56	59	59	58	52
2496.00	38	18	7	8	29	40	49	55	57	59	56	50

PROBABILITY OF FAILURE (in each given month)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
249.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
499.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
748.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
998.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1248.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1497.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1747.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2246.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2496.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSTALLED CAPACITY 1000.00 KW

TABLE 2.4 ON-PEAK GENERATION
(12 hrs/day, 5 days/week)

FAILURES EACH MONTH (throughout 59-year streamflow record)

KWH/H	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0	0	0	0	0	0	0	0	0	0	0	0
100.00	0	0	0	0	0	0	0	0	0	0	0	0
200.00	0	0	0	0	0	0	0	0	0	0	0	0
300.00	0	0	0	0	0	0	0	0	0	0	0	0
400.00	0	0	0	0	0	0	0	0	0	0	0	0
500.00	0	0	0	0	0	0	0	0	0	0	0	0
600.00	0	0	0	0	0	0	0	0	0	0	0	0
700.00	0	0	0	0	0	0	0	0	0	0	0	0
800.00	0	0	0	0	0	0	0	0	0	0	0	0
900.00	0	0	0	1	2	0	0	0	0	0	0	0
1000.00	0	0	0	3	2	0	0	0	0	0	0	0

SPILL EACH MONTH (number of incidents in 59-year record)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	54	18	7	8	32	42	52	58	59	59	59	59
312.00	54	18	7	8	32	42	52	58	59	59	59	59
624.00	54	18	7	8	32	42	52	58	59	59	59	59
936.00	54	18	7	8	32	42	52	58	59	59	59	59
1248.00	54	18	7	8	32	42	52	58	59	59	59	58
1560.00	52	18	7	8	31	41	52	57	59	59	59	57
1872.00	50	18	7	8	31	41	52	56	59	59	59	54
2184.00	44	18	7	8	30	41	52	56	59	59	59	52
2496.00	38	18	7	8	29	40	49	55	57	59	56	50
2808.00	33	18	7	8	27	35	46	53	57	57	55	47
3120.00	28	18	7	8	21	34	45	49	57	55	52	45

PROBABILITY OF FAILURE (in each given month)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
312.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
624.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
936.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1248.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1560.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1872.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2184.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2496.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2808.00	0.0	0.0	0.0	0.017	0.034	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3120.00	0.0	0.0	0.0	0.051	0.034	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSTALLED CAPACITY 400.00 KW

TABLE 2.6 24-HOUR CONTINUOUS GENERATION

FAILURES EACH MONTH (throughout 59-year streamflow record)

KWH/H	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0	0	0	0	0	0	0	0	0	0	0	0
40.00	0	0	0	0	0	0	0	0	0	0	0	0
80.00	0	0	0	0	0	0	0	0	0	0	0	0
120.00	0	0	0	0	0	0	0	0	0	0	0	0
160.00	0	0	0	0	0	0	0	0	0	0	0	0
200.00	0	0	0	0	0	0	0	0	0	0	0	0
240.00	0	0	0	0	0	0	0	0	0	0	0	0
280.00	0	0	0	0	0	0	0	0	0	0	0	0
320.00	0	0	0	1	2	0	0	0	0	0	0	0
360.00	0	0	0	3	2	0	0	0	0	0	0	0
400.00	0	1	2	6	5	1	0	0	0	0	0	0

SPILL EACH MONTH (number of incidents in 59-year record)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	54	18	7	8	32	42	52	58	59	59	59	59
350.40	54	18	7	8	32	42	52	58	59	59	59	59
700.80	54	18	7	8	32	42	52	58	59	59	59	59
1051.20	54	18	7	8	32	42	52	58	59	59	59	59
1401.60	53	18	7	8	32	41	52	58	59	59	59	57
1752.00	51	18	7	8	31	41	52	56	59	59	59	54
2102.40	45	18	7	8	30	41	52	56	59	59	59	52
2452.80	41	18	7	8	30	40	50	55	57	59	56	50
2803.20	33	18	7	8	28	35	47	53	57	57	54	46
3153.60	28	18	7	8	21	34	45	49	57	55	51	43
3504.00	23	16	7	7	16	34	41	46	52	53	45	40

PROBABILITY OF FAILURE (in each given month)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
350.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
700.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1051.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1401.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1752.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2102.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2452.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2803.20	0.0	0.0	0.0	0.017	0.034	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3153.60	0.0	0.0	0.0	0.051	0.034	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3504.00	0.0	0.017	0.034	0.102	0.085	0.017	0.0	0.0	0.0	0.0	0.0	0.0

INSTALLED CAPACITY 300.00 KW

TABLE 2.5 24-HOUR CONTINUOUS GENERATION

FAILURES EACH MONTH (throughout 59-year streamflow record)

KWH/H	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0	0	0	0	0	0	0	0	0	0	0	0
30.00	0	0	0	0	0	0	0	0	0	0	0	0
60.00	0	0	0	0	0	0	0	0	0	0	0	0
90.00	0	0	0	0	0	0	0	0	0	0	0	0
120.00	0	0	0	0	0	0	0	0	0	0	0	0
150.00	0	0	0	0	0	0	0	0	0	0	0	0
180.00	0	0	0	0	0	0	0	0	0	0	0	0
210.00	0	0	0	0	0	0	0	0	0	0	0	0
240.00	0	0	0	0	0	0	0	0	0	0	0	0
270.00	0	0	0	0	0	0	0	0	0	0	0	0
300.00	0	0	0	0	1	0	0	0	0	0	0	0

SPILL EACH MONTH (number of incidents in 59-year record)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	54	18	7	8	32	42	52	58	59	59	59	59
262.80	54	18	7	8	32	42	52	58	59	59	59	59
525.60	54	18	7	8	32	42	52	58	59	59	59	59
788.40	54	18	7	8	32	42	52	58	59	59	59	59
1051.20	54	18	7	8	32	42	52	58	59	59	59	59
1314.00	54	18	7	8	32	41	52	58	59	59	59	57
1576.80	52	18	7	8	31	41	52	57	59	59	59	57
1839.60	51	18	7	8	31	41	52	56	59	59	59	54
2102.40	45	18	7	8	30	41	52	56	59	59	59	52
2365.20	42	18	7	8	30	40	51	56	58	59	56	50
2628.00	36	18	7	8	29	38	47	55	57	58	55	47

PROBABILITY OF FAILURE (in each given month)

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
262.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
525.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
788.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1051.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1314.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1576.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1839.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2102.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2365.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2628.00	0.0	0.0	0.0	0.0	0.017	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2.4 24-Hour Continuous Generation

Since it is undetermined whether the small hydro installation will be used by the Water Resources Authority for on-peak generation or base load continuous generation, a series of computer analyses was also made for 24-hour continuous generation. This requires a very simple modification of the computer program developed. All it required was to change the number of on-peak hours per month to the total number of hours per month.

2.5 A Simplified Hydrologic Analysis

The analysis that follows was used to check the computer program developed which uses sophisticated routing to determine the installed capacity, firm power level as well as hydroelectricity generation.

The average discharge, averaging over 59 years or 708 monthly periods, is:

$$\bar{Q} = \frac{60104.3(AF) \times 43560(ft^3/AF)}{365 \times 24 \times 3600} = 83.02 cfs$$

The number of on-peak hours used is 3720 hours

The average on-peak hours per day

$$= \frac{3120}{365} = 8.55 \text{ hrs.}$$

$$\text{Power} = \frac{\gamma \bar{Q} \bar{h}}{550} \times 0.761 \times e$$

$$= \frac{62.4 \times 83.02 \times 88.3}{550} \times 0.761 \times 0.9$$

$$= 567.82 \text{ KW}$$

If turbine is operating on the average of 8.55hrs. per day,

$$\text{Power} = 567.82 \times \frac{24}{8.55} = 1593.88 \text{KW}$$

The computer analysis shows that approximately 50% of inflow is spilled. Therefore a rough estimate of the firm power level is:

$$\frac{1593.88}{2} = 793.94 \text{ KW} \approx 800 \text{KW}$$

2.5 A Simplified Hydrologic Analysis(cont'd)

The number agrees well with the computer results and therefore, verified calculations in the computer program.

2.6 Summary and Conclusion

From the pure hydrologic analysis point of view the following results obtain for each type of generation mode:

a) On-peak Generation based upon Table 2.2:

The existing dam and reservoir is capable of producing approximately 800KW firm power each year. Assuming there is no penstock limitation, the installed capacity would be about 800KW. The corresponding yearly hydroelectricity generating is about 2.5 million KWHR.

Intermittent but knowable rate of failure in meeting the firm power level being acceptable, the yearly hydroelectricity generation would be considerably more. For example, if one is willing to accept a 5% probability of failure, the yearly hydroelectricity generation would be about 3.1 million KWH with an installed capacity of 1000KW.

However, the concept of firm power assumes that the system will provide dependable power without failure. In this case, it is recommended that 800KW represent the installed capacity for year 'round 12 hour a day peak power generation.

b) 24-Hour Continuous Generation:

Results show that the reservoir system is capable of generating 300KW of round the clock firm power at an installed capacity of 300KW. The corresponding yearly hydroelectricity generation is about 2.6 million KWHR. Again, this is purely from the hydrologic analysis point of view. Mechanical, penstock, or other limitations are not considered in this section. It appears that if the system is used to generate base load in displacement of thermal generation, one should be willing to accept a certain probability of failure. For example, if a 10% probability of failure is acceptable the yearly hydroelectricity generation at the Patillas Reservoir would be about 3.5 million KWH at an operating capacity of 400KW at the earth dam irrigation outlet structure.

3.0 Engineering Feasibility & Design Concept for Hydropower Retrofit at Patillas, Puerto Rico

3.1 Introduction

There are multiple hydropower retrofit alternatives feasible at the Patillas site, after examination of selected configurations. From an engineering standpoint, three possibilities were selected for generating hydroelectric power at existing facilities.

The first alternative is a hydropower installation at the existing irrigation outlet structure at the earth dam, using irrigation water for power generation and discharging it into the existing irrigation canal. This is recommended as the most attractive development at this time.

The second alternative for hydropower installation is at the Spillway, using surplus reservoir storage water normally spilled in addition to irrigation releases and discharging the tailwater to the natural streambed.

The third alternative is a hydropower installation on the irrigation canal, implanted at the Felícita Syphon, using water discharged by the first hydropower installation and discharging it again into the irrigation canal.

All three alternatives are possible phases of project development for consecutive implementation (see Figure 3.1)

3.2 Hydropower System Design & Estimates: Development of the Concept

3.2.1 Irrigation Outlet Hydropower Generating System, Design Criteria & Operating Regime

The existing irrigation water outlet structure(Fig. 3.2) feeding the irrigation canal, as modified in 1961, consists of a 54" steel pipe installed in a concrete-lined tunnel discharging to an uptake shaft which raises the water to the level of an open irrigation canal. Flow rate is controlled by means of gate valves between the 54" pipe and the uptake shaft. Water level in the re-

VIEW OF THE IRRIGATION CANAL AND DIVERSION STRUCTURE
FROM THE TOP OF THE EARTH DAM

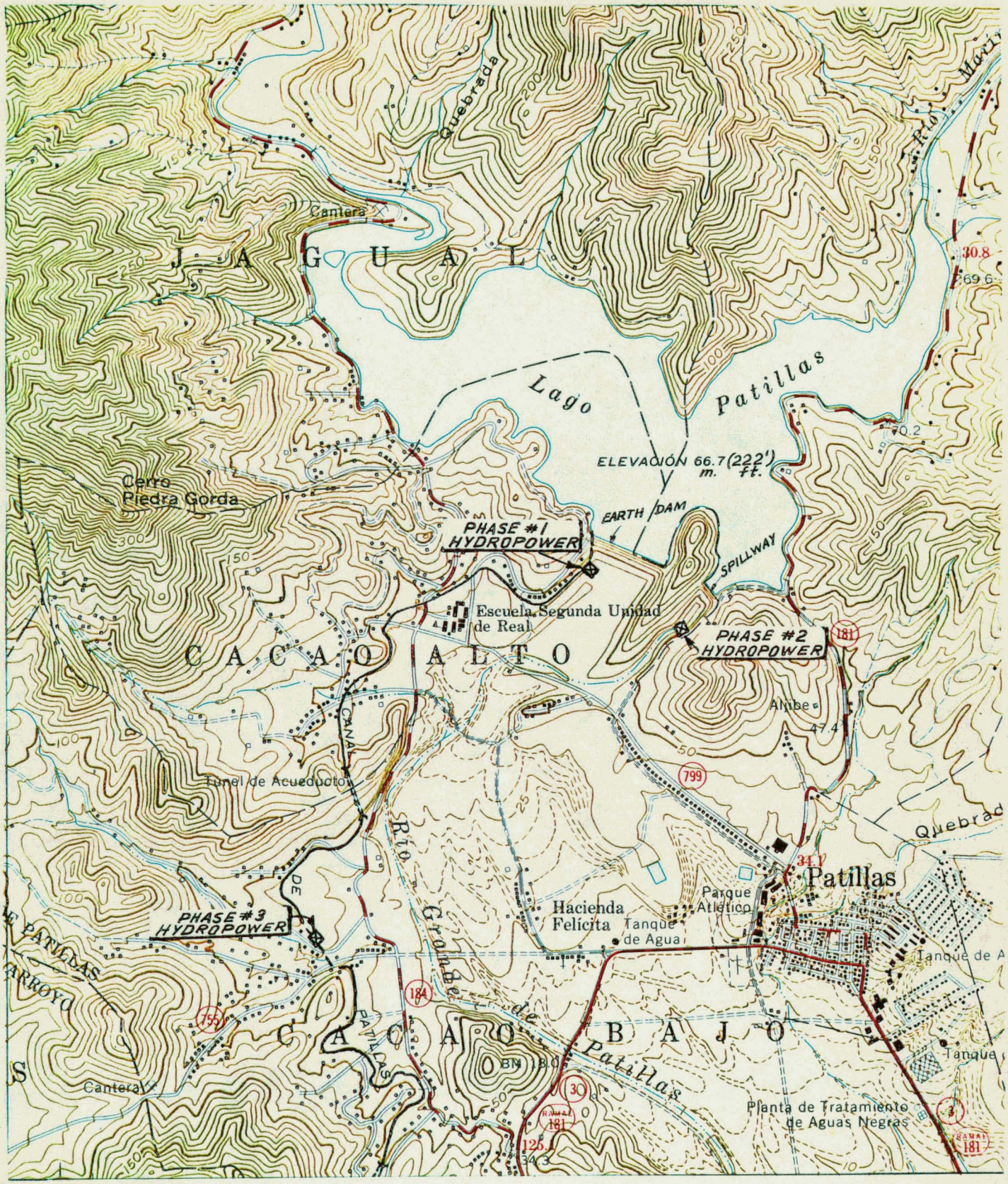


FIGURE 3.1 General View of Patillas Site and Location of Hydropower Installations Feasible According to Engineering & Construction Criteria

servoir varies from approximately 80ft. to zero feet above the level of water in the irrigation canal. The head range considered for power generation is 80--42 ft.(Median head=60ft). This hydraulic discharge can be converted to electrical power by diverting the water from the existing uptake riser and passing it through a turbine/generator before discharging it to the open channel of the irrigation canal.

The optimal storage regime for generating power at Patillas reservoir is between 5,000 AF(w.s. elevation 187.5ft. above sea level) and 14,000 AF(w.s. elevation 222.0ft. A.S.L.).

Based on the irrigation water delivery requirements at a documented average flow of 70c.f.s.; maximum 105c.f.s., water surface elevation in the reservoir will vary between 189ft. and 222ft. (crest of Spillway) above sea level, which corresponds to optimal needs for generating electrical power.

Hydroelectric power can be estimated by the formula:

$$P = \frac{Q\ h\ e}{11.8} \qquad *)$$

where

P = power production in kilowatts
Q = flow through turbine in cubic feet per second
h = head on the turbine in feet
e = efficiency, which is assumed to be 0.9

Head loss by pipe friction can be estimated by the Darcy-Weisbach equation:

$$h_{loss} = F \frac{L}{D} \frac{V^2}{2g}$$

where

L = length of the pipe in feet
D = diameter of pipe in feet
F = friction factor(0.014 for steel pipe)
V = water velocity(feet/sec)
g = gravity acceleration

*This formula is currently used by the U.S. Army Corps of Engineers to estimate hydroelectric power potential at existing small dams.

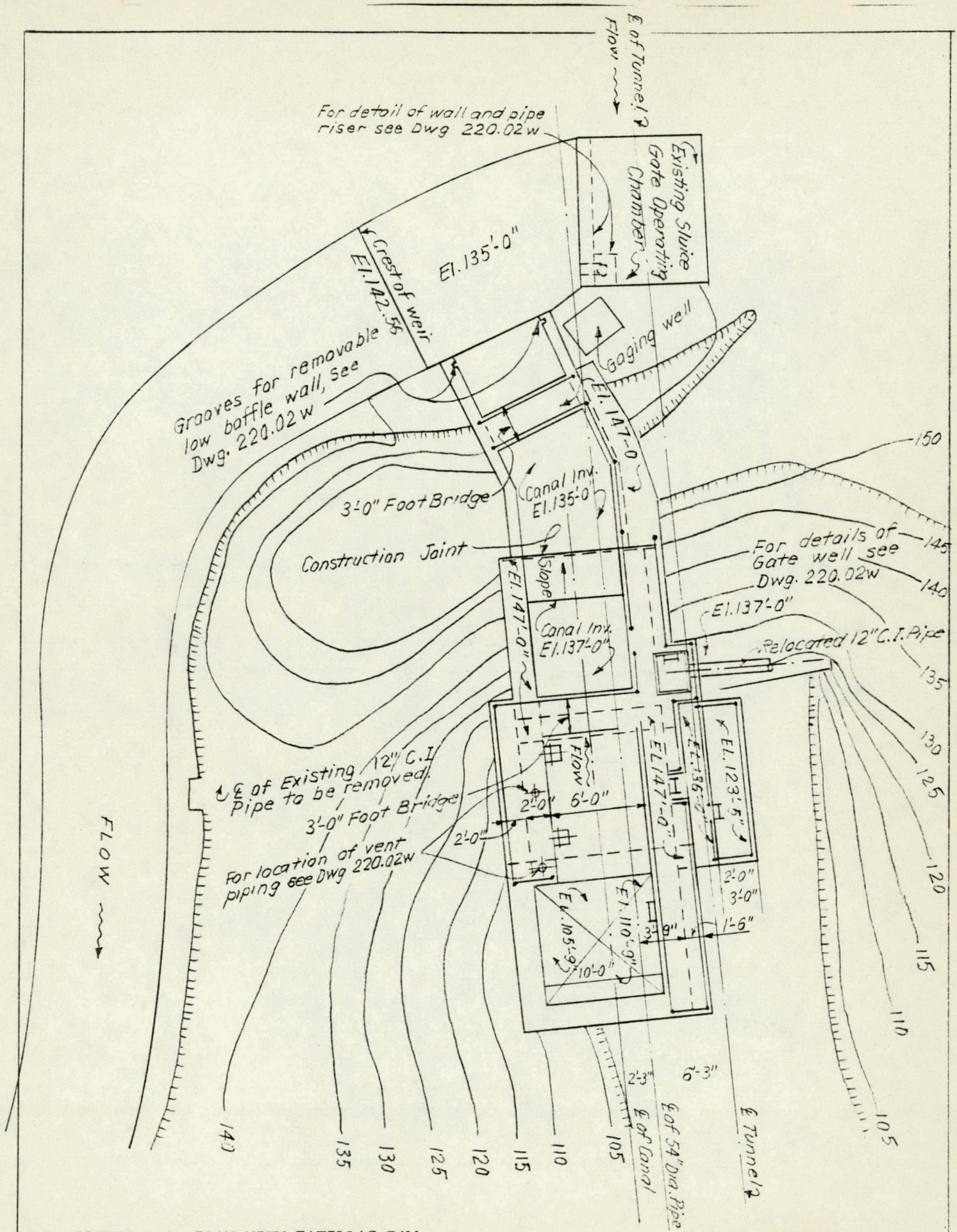


FIGURE 3.2--PLAN VIEW PATILLAS DAM
OUTLET STRUCTURE
(for PRWRA-E&CD, Dwg. 1-H220W,1960)

VIEW OF THE IRRIGATION DIVERSION STRUCTURE FROM THE IRRIGATION CANAL. THE UNIMPROVED AREA BETWEEN THE EXISTENT STRUCTURE AND THE CANAL WALL IS THE PROPOSED SITE OF THE PHASE I POWERHOUSE.

In our case, head loss is negligible as head loss for 1000ft. length, 4.5 ft. diameter pipe is only 0.29ft. (total pipe length is less than 500ft.)

3.3 Hydropower Installation at Irrigation Outlet Structure(Phase I)

The most attainable configuration for power recovery with a high level of determined feasibility is the utilization of the uptake shaft at the reservoir outlet where it connects to the open channel irrigation canal.

Two types of turbine configuration can be used for small hydropower installation: vertical and horizontal.

3.3.1 Vertical Turbine Configuration Concept Design

In Figure 3.3.1, a and b, concept design of vertical arrangement turbine installation is represented. The following are key parameters of this installation:

1) Equipment Items

   a. Powerhouse construction - reinforced concrete for foundation and draft connection, corrugated galvanized metal for walls and roof(as currently used for structures at dam).

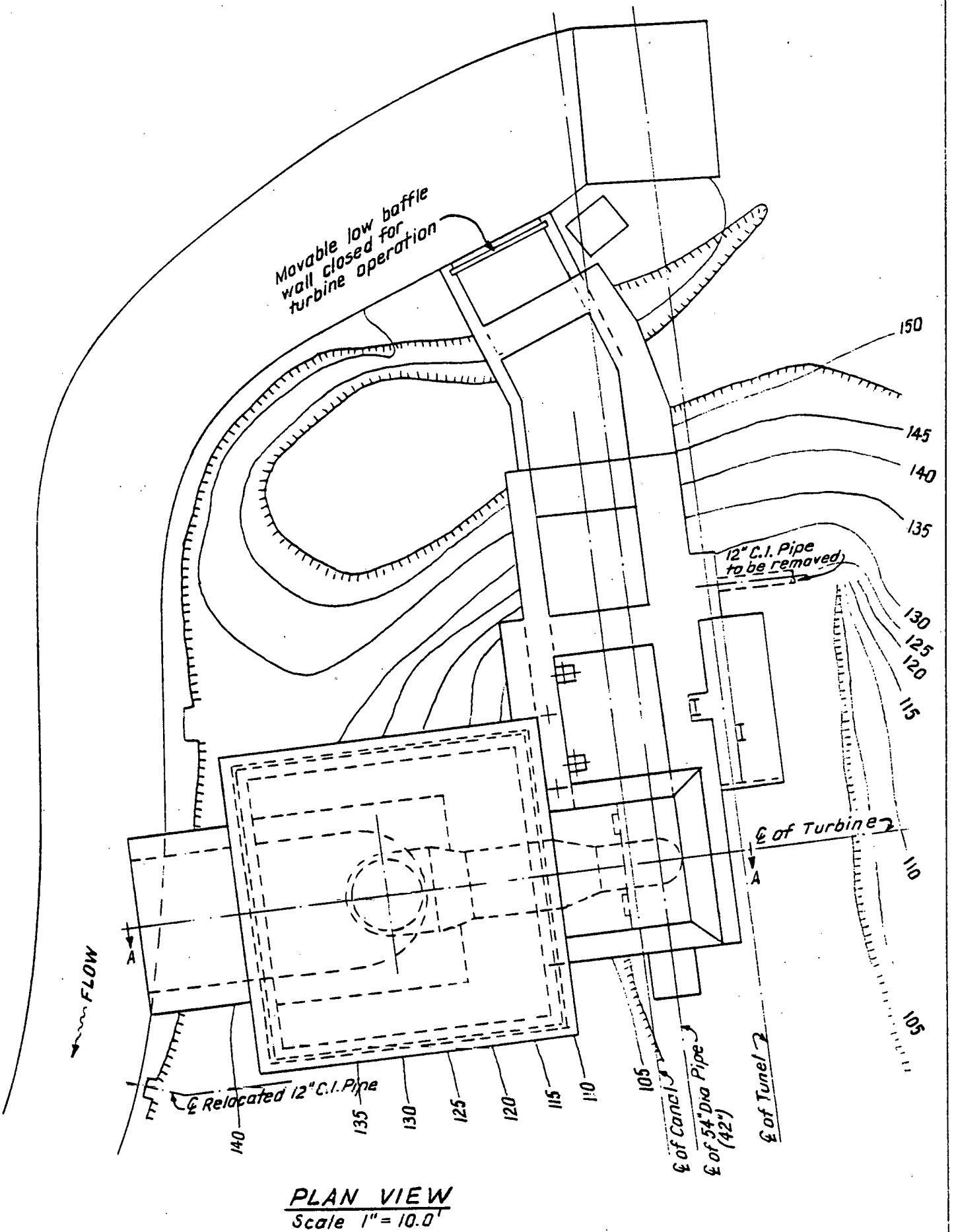
   b. Turbine, propeller type-standardized*

   c. Generator type TBD with power output 300-700KW range. Determination will be made as to variable speed generator or automatic controllable gear box requirement.

   d. Switch panel and automatic controls

   e. Riser penstock pipe(welded steel pipe 42" dia. 56ft. length.

* Some domestic and foreign companies have standardized design for small propeller turbines, e.g. Allis-Chalmers-USA, Bofors-Nåhab-Sweden, Staphenhorst-Canada,etc.



PLAN VIEW
Scale 1" = 10.0'

FIGURE 3.3.1a RETROFIT HYDROPOWER INSTALLATION at EARTH DAM OUTLET STRUCTURE VERTICAL TURBINE CONFIGURATION

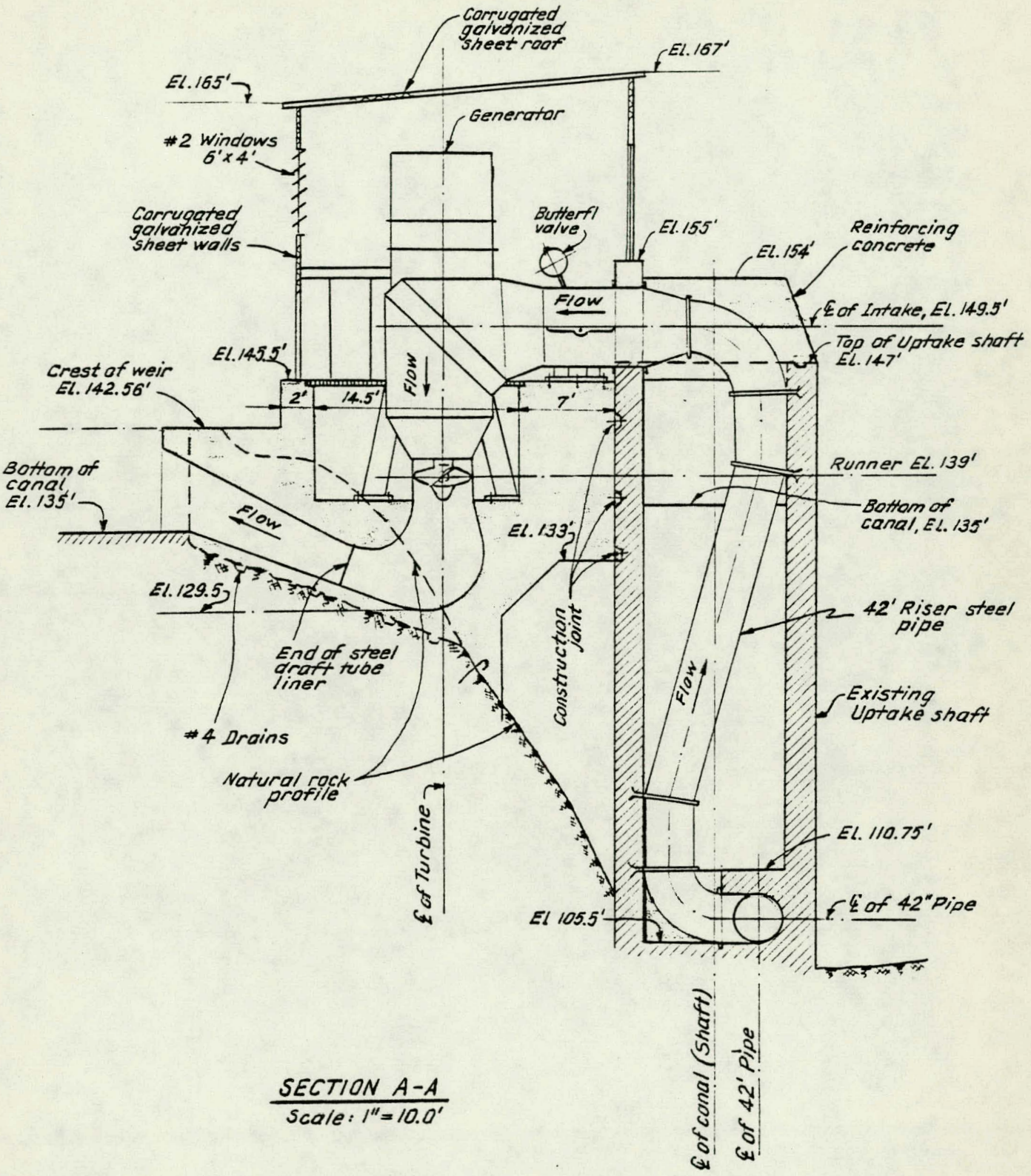


FIGURE 3.3.1b RETROFIT HYDROPOWER INSTALLATION AT EARTH DAM OUTLET STRUCTURE VERTICAL TURBINE CONFIGURATION

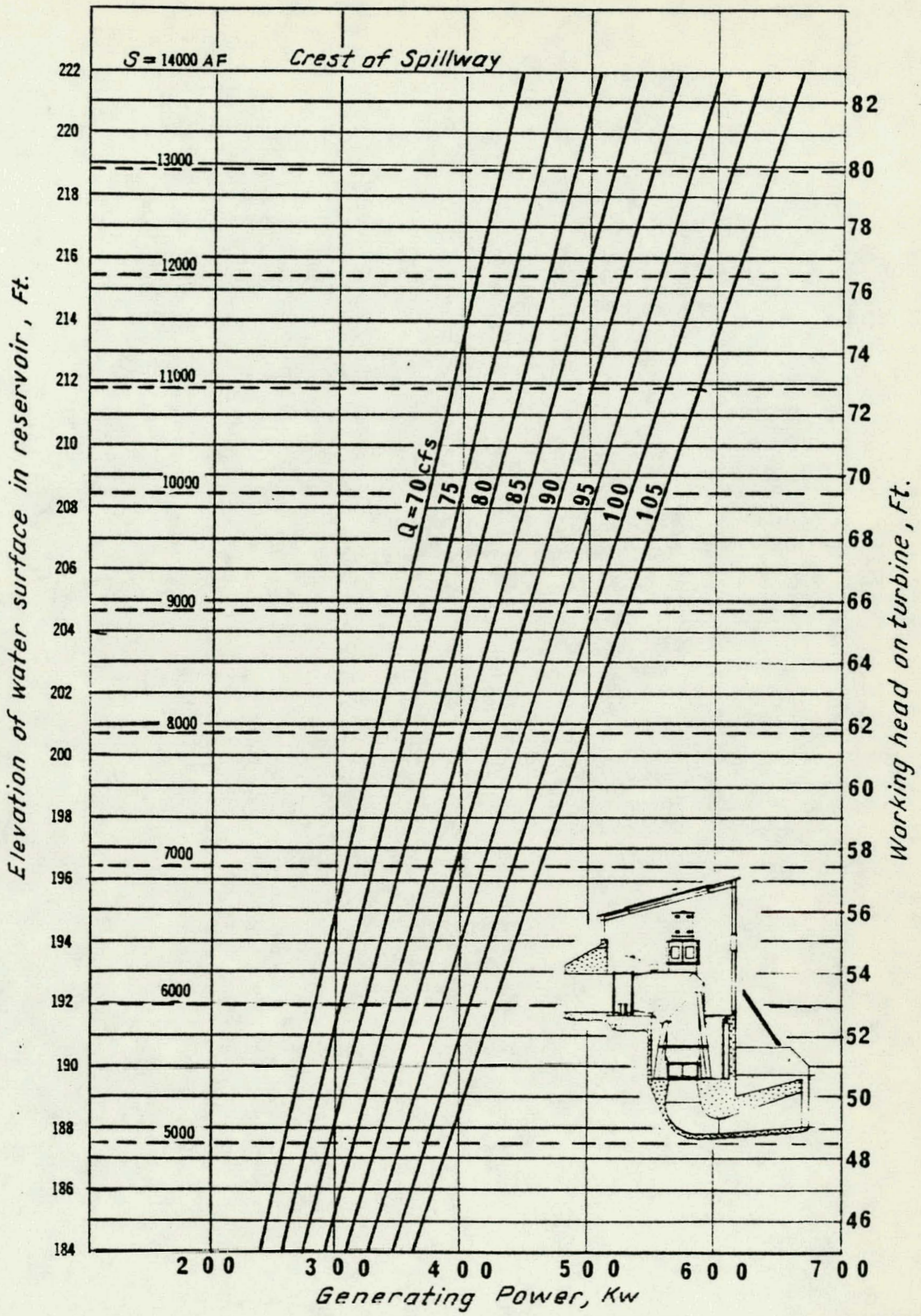


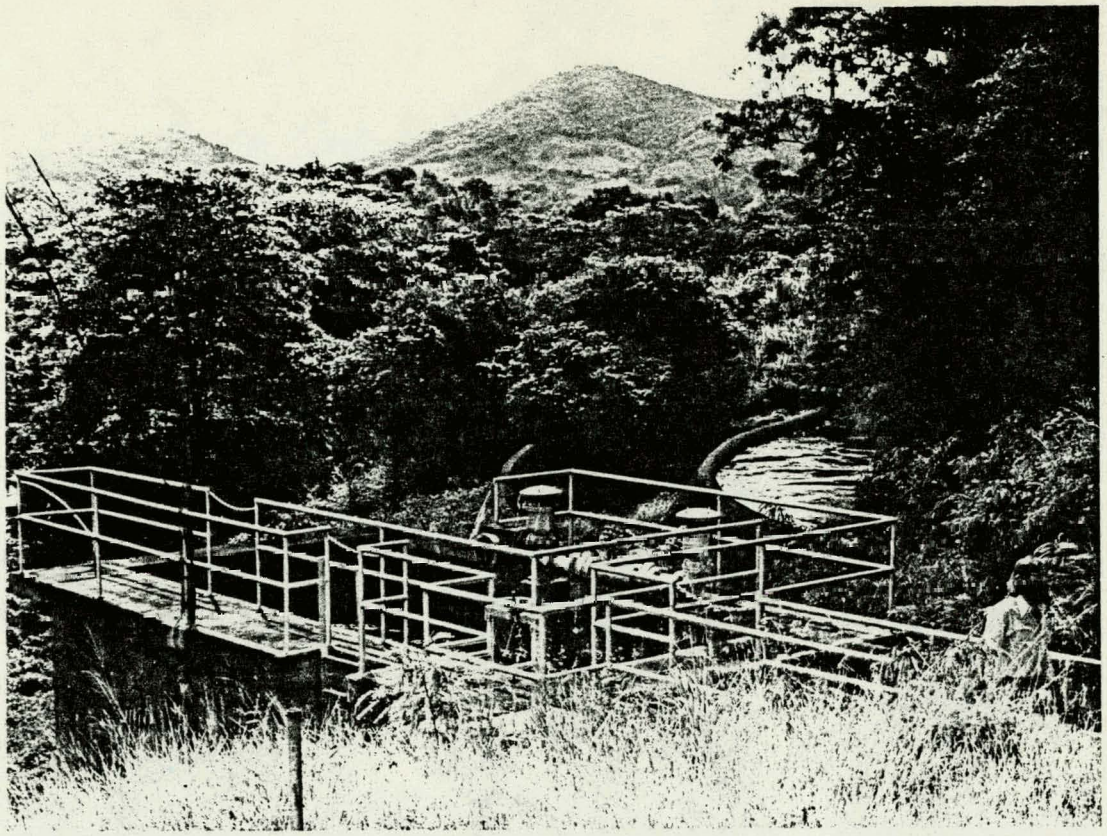
FIGURE 3.3.1c CORRELATION BETWEEN WORKING HEAD ON TURBINE, DISCHARGED FLOW and GENERATED POWER FOR VERTICAL TURBINE ARRANGEMENT

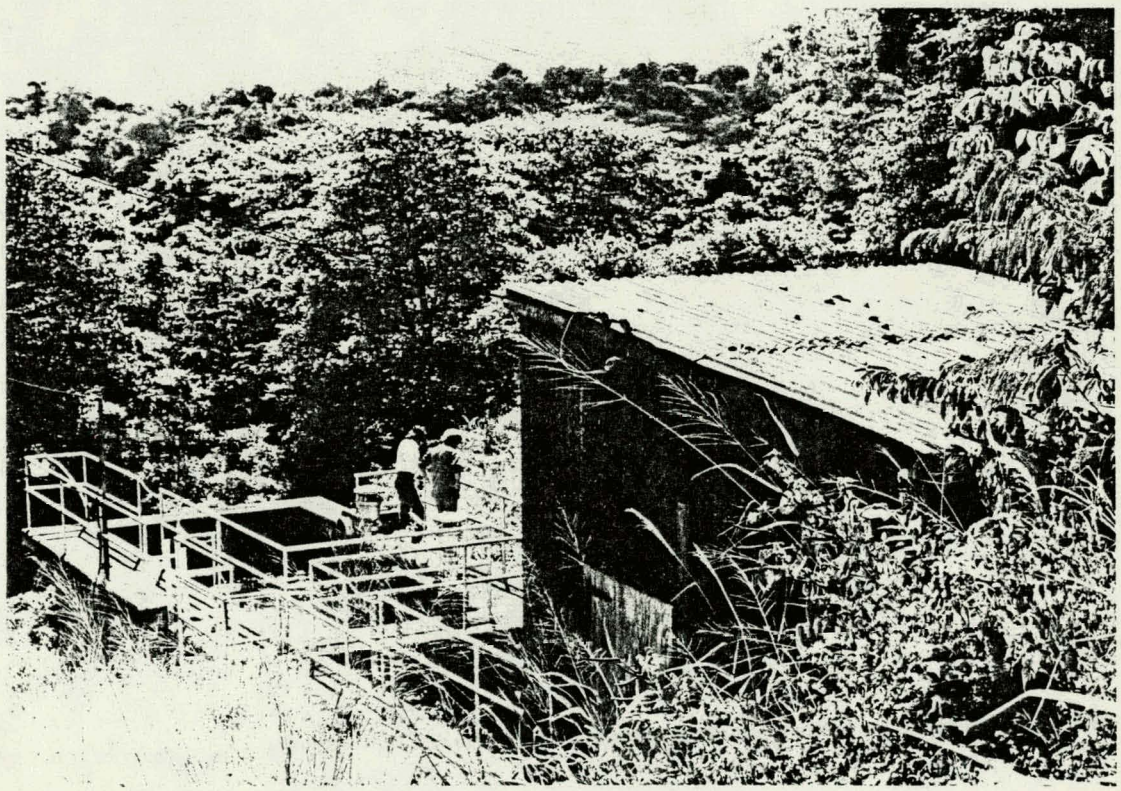
TABLE 3.3.1

ESTIMATED COSTS FOR HYDROPOWER INSTALLATION
AT EARTH DAM (VERTICAL ARRANGEMENT)

PATILLAS, PUERTO RICO

1.	Contractor start-up cost Move on site, clean-up and move off Excavation, joining existing structure and rock fill	30,000.00
2.	Powerhouse construction (600 sq.ft.)	4,800.00
3.	Reinforcing concrete in place 210 cu. yd. X $230/cu. yd.	48,300.00
4.	Miscellaneous iron	8,000.00
5.	Penstock pipe 48" dia. 1/2" wall 56ft. long @ $90/ft.	5,040.00
6.	Turbine, generator, switch panel and automatic controls	236,782.00
7.	Install and test	20,000.00
	Sub-total	$352,922.00
	Allowance for unlisted items - 10%	35,292.00
	Sub-total	388,214.00
	Engineering design - 10%	38,821.00
	Sub-total	427,035.00
	Contingency - 10%	42,704.00
TOTAL ENGINEERING and CONSTRUCTION		$469,739.00
	INTERIM CALCULATION	$470,000.00





Construction of a powerhouse at the present outlet point at the earthdam has strong feasibility (Phase 1). Above, two views of the present irrigation outlet structure, with team members observing the site of the proposed powerhouse.

3.3.1 Vertical Turbine Configuration Concept Design (cont'd)

2) Hydrotechnical Parameters

a. Elevation of turbine intake = 149.5ft.

b. Turbine intake diameter varies by manufacturer between 1370 and 1795 mm.

c. Turbine runner elevation = 139ft.

d. Runner diameter: 1000-1150 mm.

e. Effective working head on turbine is 83ft. to 48ft. (head to achieve rated power)

f. Generating power estimated applying above formula.

P_{min} = 256KW for Q = 70cfs and h = 48ft.

P_{max} = 665KW for Q = 105cfs and h = 83ft.

(Illustration of rated power, See Figure 3.3.1c)

g. Estimated cost of project is shown in Table 3.3.1.

3.3.2 Horizontal Turbine Configuration Concept Design

Concept design of a horizontal turbine arrangement is represented in Figure 3.3.2-a and b. The following are the key parameters of this installation:

1) Equipment Items

a. Powerhouse construction as per vertical arrangement.

b. Propeller type turbine - custom design(standardized horizontal turbines do not correspond to the Patillas conditions, they are designed for 7 to 17ft. head and discharging flow of 200cfs and over).

c. Generator TBD - as for vertical arrangement.

d. Switch panel & automatic controls.

e. Riser pipe as for vertical arrangement.

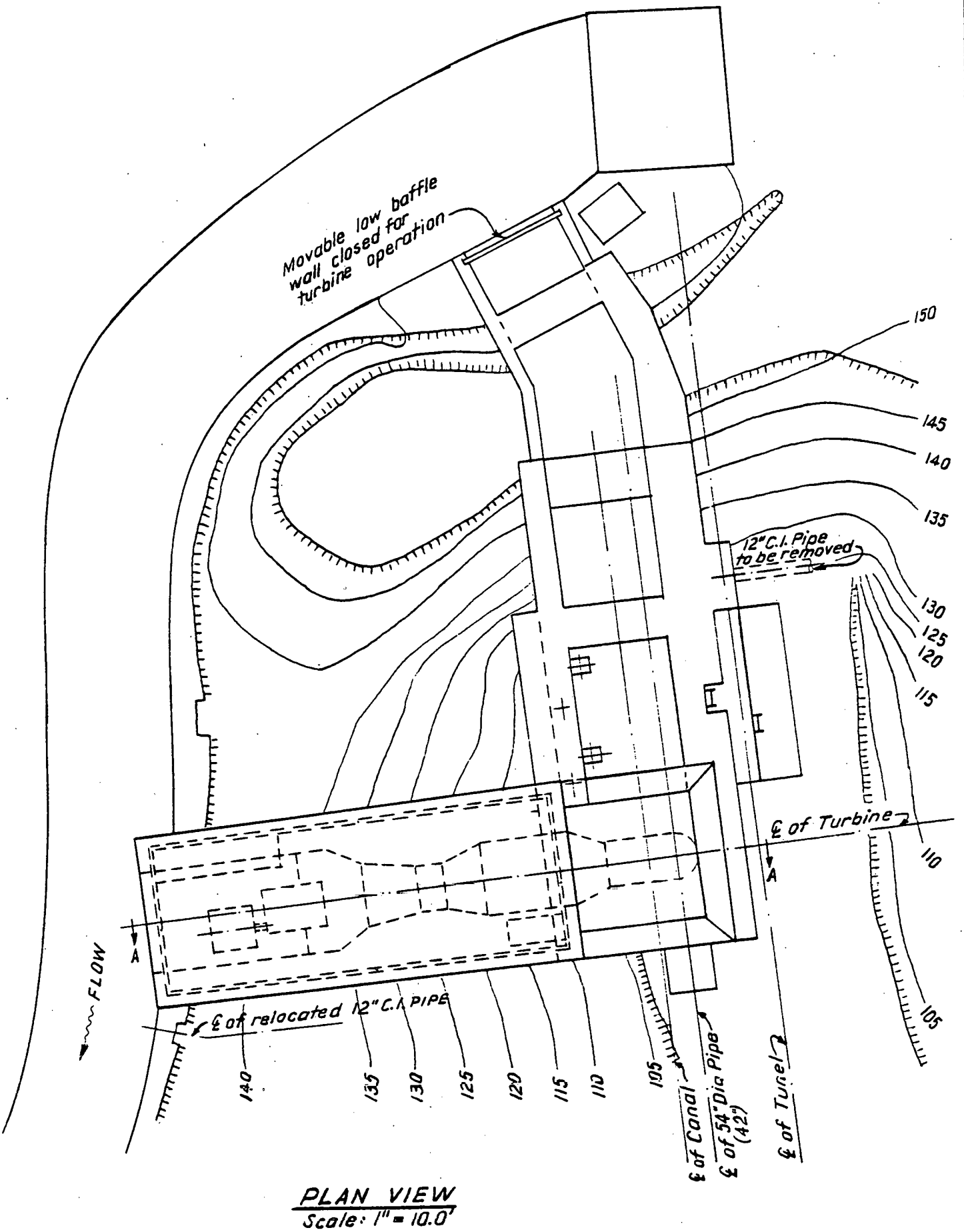
2) Hydrotechnical Parameters

a. Elevation of the center line of turbine intake, from shaft to turbine = 145ft.

b. Turbine intake diameter varies between 1370-1795 mm.

c. Turbine runner centerline elevation = 145ft.

d. Turbine runner diameter: 1000-1150 mm.



PLAN VIEW
Scale: 1" = 10.0'

FIGURE 3.3.2a RETROFIT HYDROPOWER INSTALLATION AT EARTH DAM OUTLET STRUCTURE HORIZONTAL TURBINE CONFIGURATION

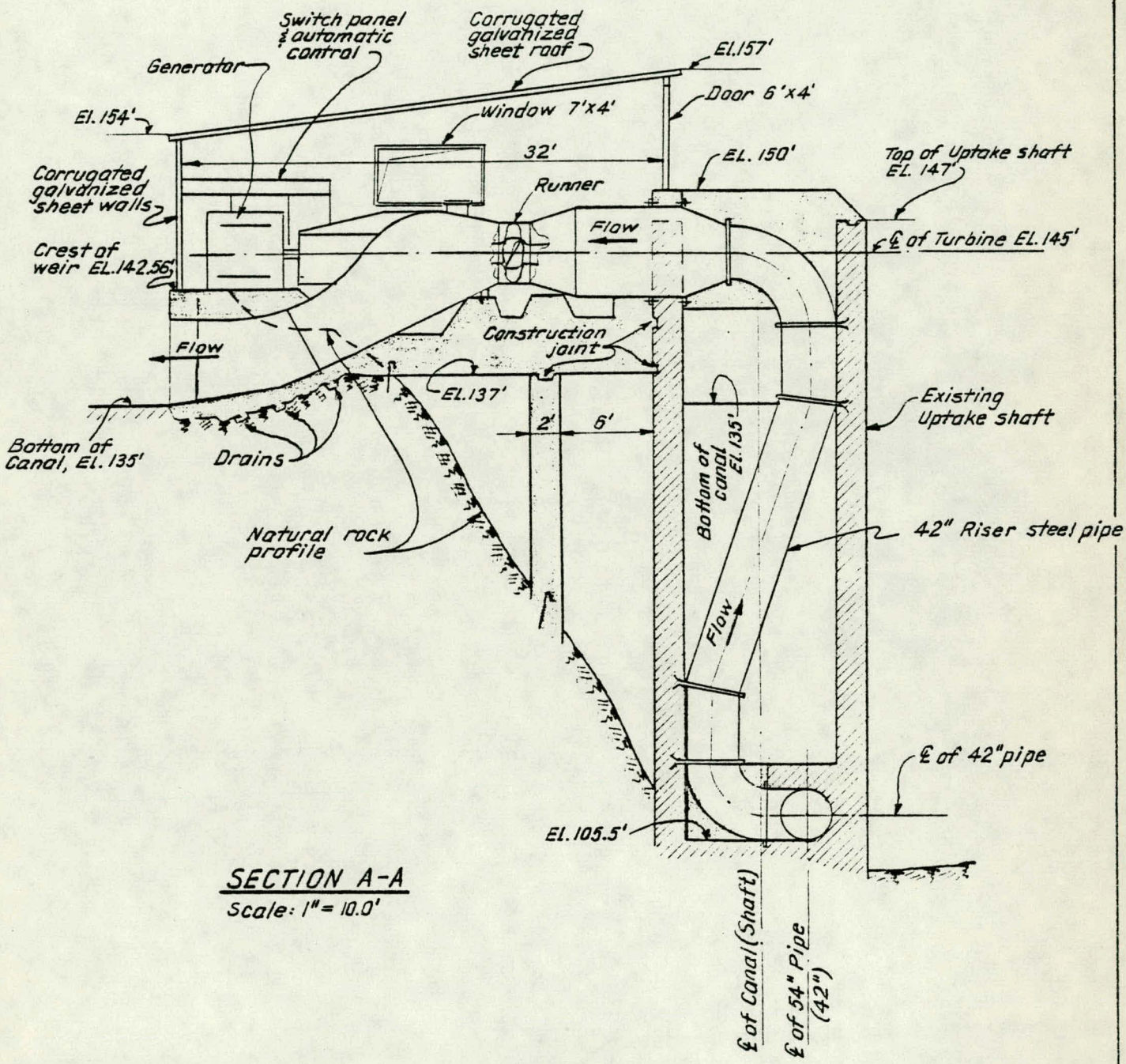


FIGURE 3.3.2b RETROFIT HYDROPOWER INSTALLATION at EARTH DAM OUTLET STRUCTURE HORIZONTAL TURBINE CONFIGURATION

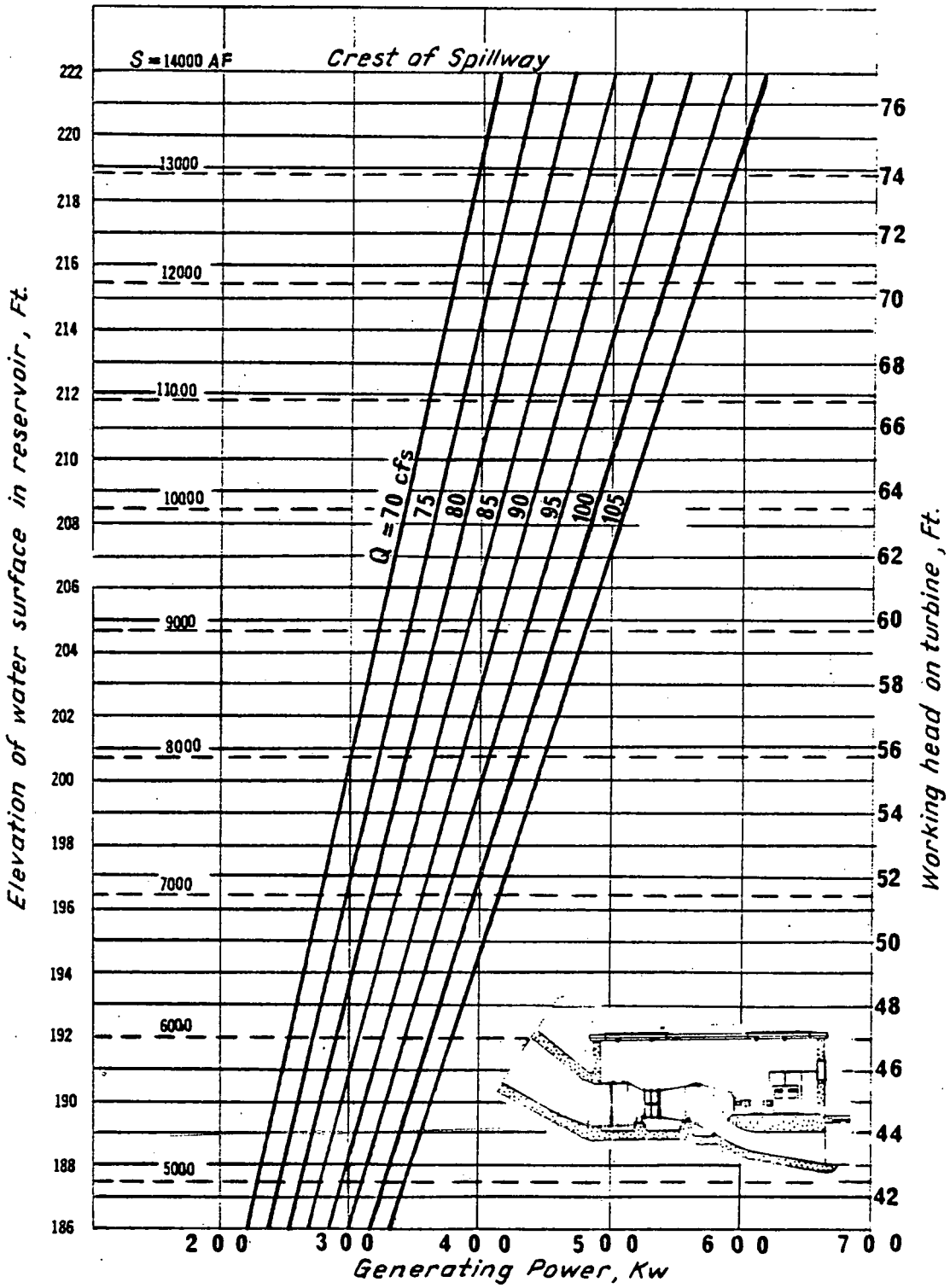


FIGURE 3.3.2c CORRELATION BETWEEN WORKING HEAD on TURBINE DISCHARGE FLOW and GENERATED POWER for HORIZONTAL TURBINE ARRANGEMENT

TABLE 3.3.2

ESTIMATED COSTS FOR HYDROPOWER INSTALLATION
AT EARTH DAM (HORIZONTAL ARRANGEMENT)
PATILLAS, PUERTO RICO

1. Contractor start-up cost Move on site, clean-up and move off Excavation, joining existing structure and rock fill	$ 30,000.00
2. Powerhouse construction 490 sq.ft.	3,900.00
3. Reinforcing concrete in place 121 cu. yd. X $230/cu. yd.	27,830.00
4. Miscellaneous iron	8,000.00
5. Penstock pipe 48" dia. 1/2" wall 56 ft. long @ $90/ft.	5,040.00
6. Turbine, generator, switch panel and automatic controls	300,000.00
7. Install and test	20,000.00
Sub-total	$394,770.00
Allowance for unlisted items-10%	39,477.00
Sub-total	434,247.00
Engineering design 10%	43,425.00
Sub-total	477,672.00
Contingency - 10%	47,767.00
TOTAL ENGINEERING and CONSTRUCTION	$525,439.00
INTERIM CALCULATION	$525,000.00

2) Hydrotechnical Parameters(cont'd)

e. Effective working head on turbine is 77ft. to 48ft. (head to achieve rated power).

f. Generating power estimated by above formula:

P_{min} = 256KW for Q = 70cfs and h = 48ft.

P_{max} = 616KW for Q = 105cfs and h = 77ft.

(Illustration of rated power, see Figure 3.3.2c)

g. Estimated cost of project shown in Table 3.3.2.

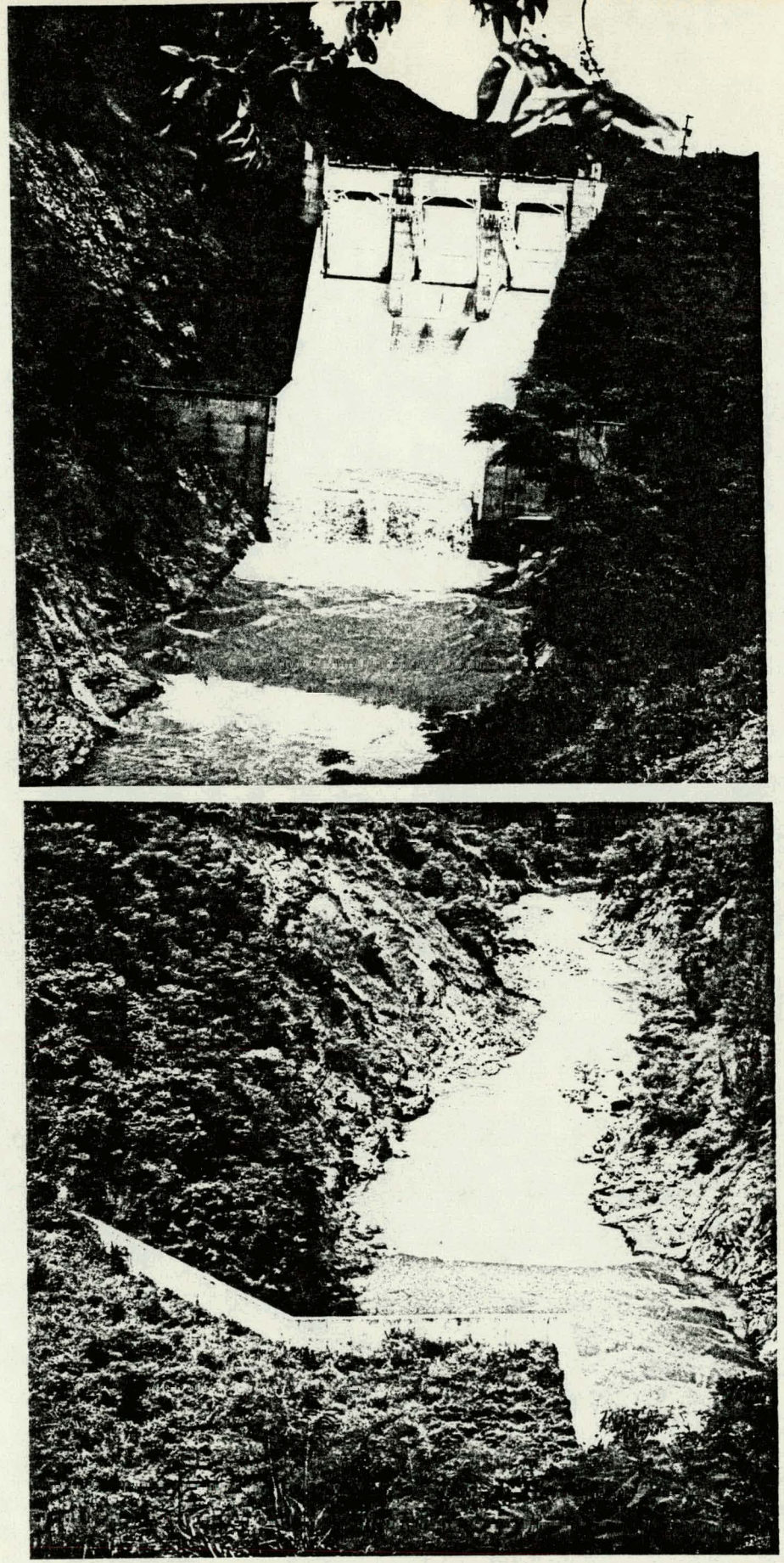
3.4 Hydropower Installation at Spillway(Phase 2-- Sketch)

The second alternative (Proposed Phase 2) of hydropower installation at Patillas site is feasible for placement at Spillway (see Figure 3.4 a&b), using surplus reservoir storage water remaining after irrigation releases. This hydropower installation is feasible for installation adjacent to the Spillway at the down stream chute wall as shown in Figure 3.4. Turbine and powerhouse construction will be as per vertical arrangement at outlet structure.

The intake structure will be at the left inlet wall of Spillway(looking downstream) with a trash rack and automatically operated gate valve. The penstock consists of a 54" steel pipe traced as shown in Figure 3.4, of 320ft. length. Water discharges in open flow to the natural streambed. The elevation of intake centerline is 193ft., turbine runner elevation is 119ft. Working head on turbine varies according to the water surface elevation in the reservoir: between 103ft. which corresponds to 222ft. w.s. elevation(crest of Spillway) and 76ft. minimum(which corresponds to 196ft. elevation of top of intake tube).

Flow is assumed at a constant 105cfs displacing some spillage requirements. Generating power is 608KW minimum to 848KW maximum. This installation can be used for peak power generation (12 hrs./day) for up to 8 months a year based on analysis of hydrologic data and irrigation delivery requirements.

The cost of project Phase 2 is presented in Table 3.3.



Two views of the Patillas spillway structure (proposed Site #2) taken from opposite angles. The proposed intake structure would be sited at the right of the present structure (top photo).

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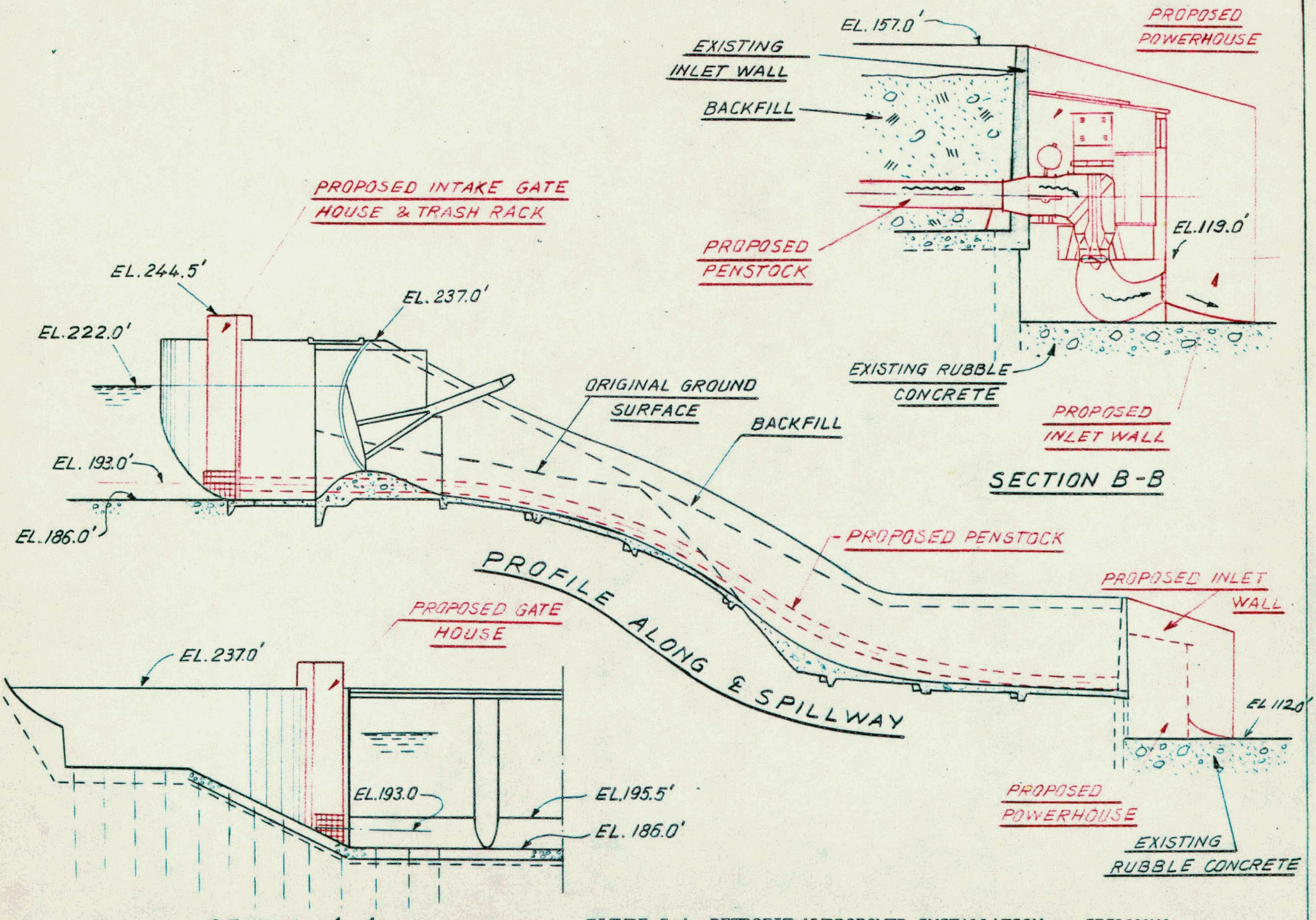


FIGURE 3.4a RETROFIT HYDROPOWER INSTALLATION at SPILLWAY

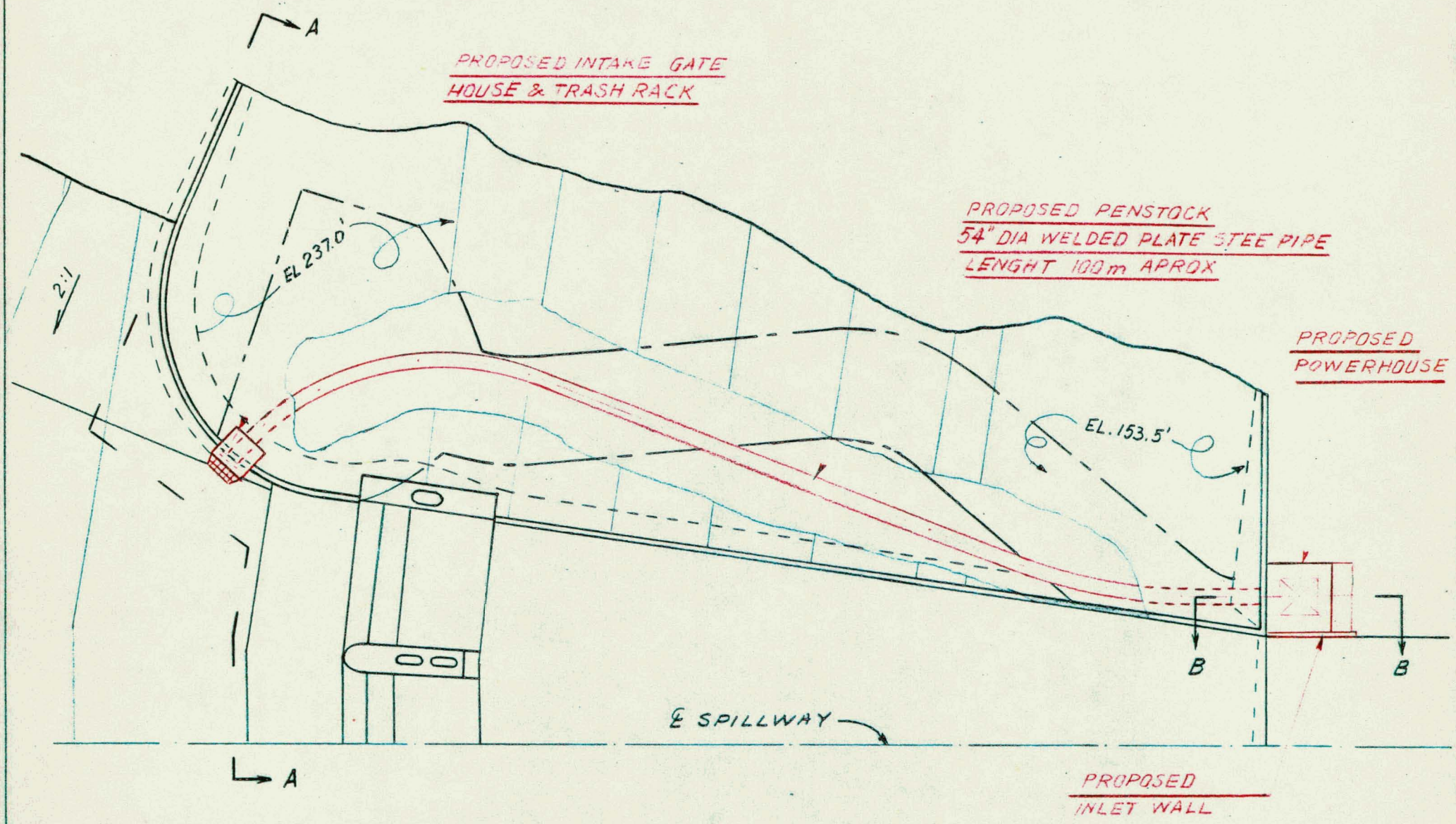


FIGURE 3.4b RETROFIT HYDROPOWER INSTALLATION
at SPILLWAY

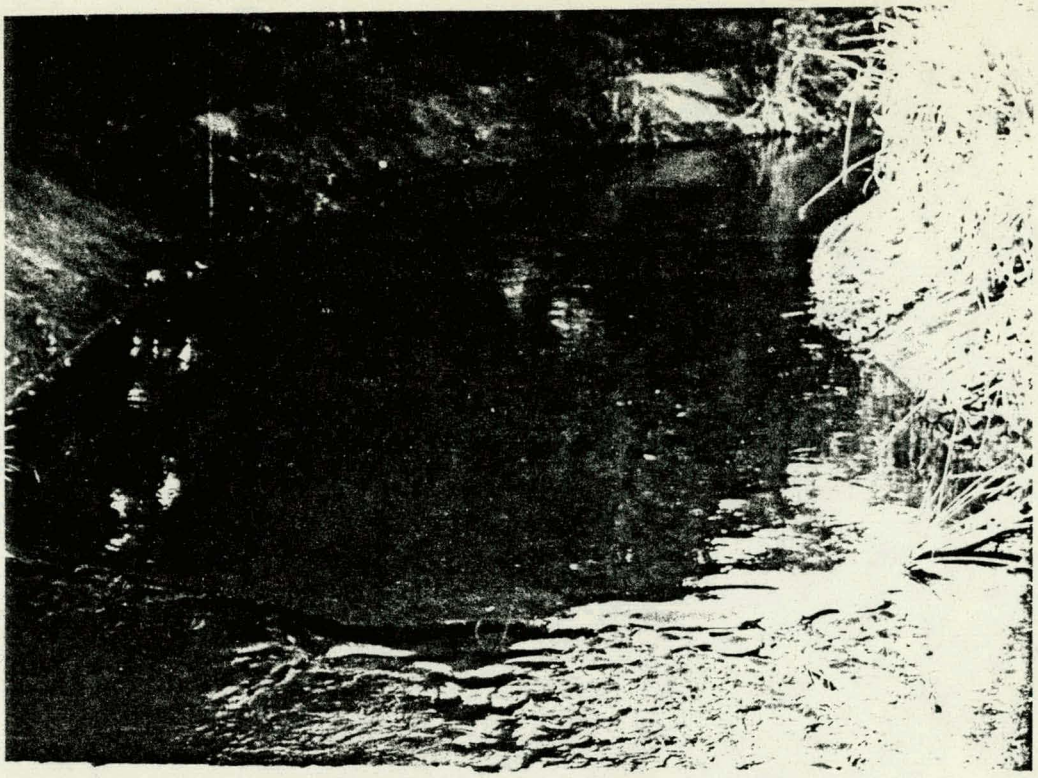
NOTICE:

Existing Spillway Structure from PRWRA - ECD - SPILLWAY REPLACEMENT - Drowing No OA-27-25

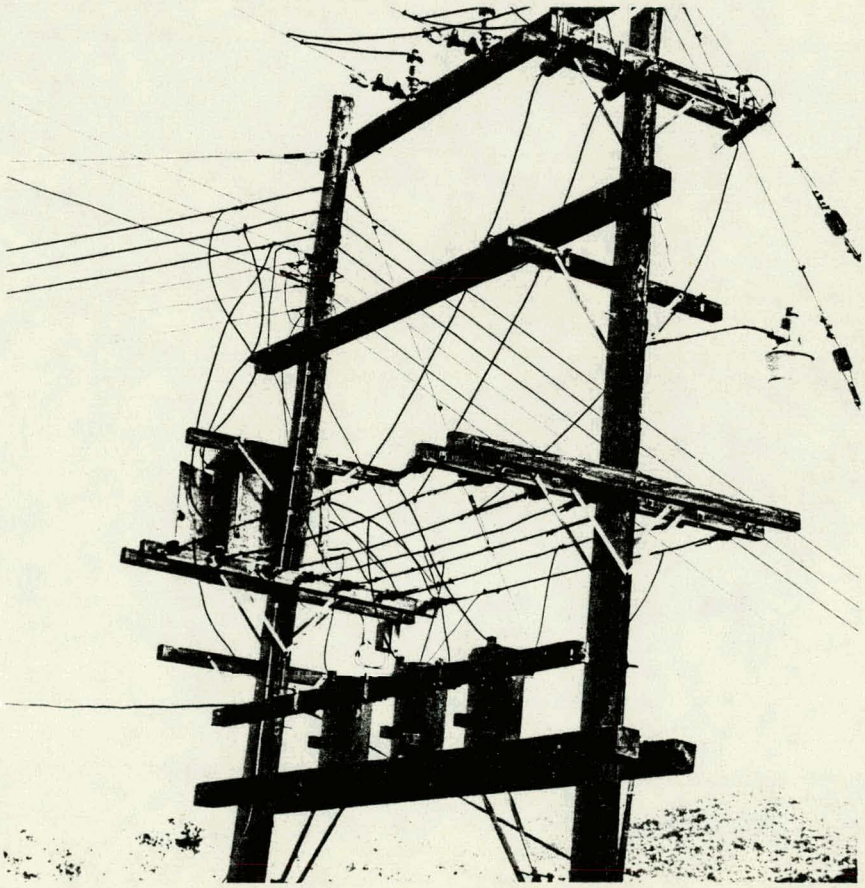
TABLE 3.3

ESTIMATED COSTS TO DESIGN AND INSTALL A HYDROPOWER PLANT AT THE EXISTING PATILLAS DAM SPILLWAY STRUCTURE.

1.	Contractor leadtime, planning and start-up, move-on, clean-up and move-off. Allow:	$ 6,000.00
2.	Site development and restoration, including: on-site access road, restoration of natural and dam surfaces, revegetation.	6,600.00
3.	Demolition and removals including breaching existing dam wall for inlet structure and area for installation of power plant structure.	12,000.00
4.	Earth work; excavation and backfill.	38,000.00
5.	Reinforced concrete in place. 350 cubic yards @ $230/cubic yard	80,500.00
6.	Miscellaneous iron.	8,000.00
7.	Penstock pipe, steel, 48" diameter 1/2" wall -- furnish and install 320 linear feet @ $121/foot.	38,720.00
8.	Powerhouse building	4,800.00
9.	Turbine, generator, switch panel and automatic controls.	236,780.00
10.	Install and test turbine.	20,000.00
	Subtotal	$451,400.00
	Allowance for unlisted items: 10%	45,140.00
	Subtotal	$496,540.00
	Engineering design: 10%	49,650.00
	Subtotal	$546,190.00
	Contingency: 10%	54,620.00
	Total Engineering & Construction	$600,810.00
	INTERIM CALCULATION	$600,000.00



As oil prices continue to rise, installation of powerhouse downstream on the irrigation canal may become attractive (Phase 3)



Interface with the existant power grid is seen as posing no problems at any of the possible Patillas sites.

3.5 Hydropower Installation at Felícita Syphon(Phase 3) Outline of Feasibility and Conditions

For further hydropower generation development, it is feasible to install a hydropower plant downstream on the irrigation canal before one of the existing syphons. The most available syphon for powerhouse installation is Felícita Syphon.

The outline of this hydropower installation is:

The tailwater discharged from the hydropower installation at the earth dam outlet structure is captured in pressure pipe 42" diameter along the existing irrigation canal (length of pipe = 8085ft.) and connected to the intake of a hydropower installation implanted into the Syphon pipe. Point of construction joint between Syphon and Powerhouse will be where Syphon pipe passes over a natural stream running perpendicular to canal flow. After passing through the turbine, water discharges to an open irrigation canal through the other end of the Syphon.

Working head on the turbine is 42ft. with generated power 225KW to 335KW depending on irrigation flow. Assuming 87cfs as the most common flow, installed capacity is rated at 316KW. The cost of project Phase 3 is presented in Table 3.5.

3.6 Conclusions

At the earth dam hydropower installation, a vertical turbine configuration is more advantageous because it responds to the most important factors, i.e.:

- standardized turbine commercially available: lower cost and technically proven.
- higher working head range on turbine: higher level of power generation for identical water surface, elevation in reservoir.
- excludes cavitation phenomena: longer life of runner (which is the most expensive part of the turbine, in most cases)

However, a vertical turbine arrangement needs a larger powerhouse, resulting in a higher cost of construction compared to a horizontal unit.

TABLE 3.5

ESTIMATED COSTS FOR HYDROPOWER INSTALLATION
AT FELÍCITA SYPHON, PATILLAS, PUERTO RICO

1.	Contractor start-up cost, move-on site, clean-up and move-off, excavation, joining existing structure and rockfill.	$ 30,000.00
2.	Power house construction.	4,800.00
3.	Reinforcing concrete in place. 121 cubic yards @ $230/cubic yard.	27,830.00
4.	Miscellaneous iron	8,000.00
5.	Penstock pipe 48" diameter, 1/2" wall. 8,085 feet long @ $90/foot.	727,650.00
6.	Turbine, generator, switch panel and automatic controls.	225,000.00
7.	Install and test.	20,000.00
	Subtotal	$1,043,280.00
	Allowance for unlisted items: 10%	104,328.00
	Subtotal	$1,147,608.00
	Engineering design: 10%	114,761.00
	Subtotal	$1,262,369.00
	Contingency: 10%	126,237.00
	Total Engineering & Construction	$1,388,606.00
	INTERIM CALCULATION	$1,390,000.00

3.6 Conclusions(cont'd)

Horizontal configuration turbine(custom design)has a lower powerhouse construction cost. This particular horizontal arrangement has a lower working-range and does not exclude possible cavitation phenomena(shorter life for runner).

Analysis of hydrological data at the Patillas earth dam outlet structure indicates that the most common conditions are: standard flow delivered for irrigation needs is 87cfs and storage volume in the reservoir is 7800 AF, which corresponds to 200ft ASL elevation or 61 ft. working head. For these common conditions, power generation will be 350-400KW.

At the Spillway hydropower installation, it is more feasible to use a vertical turbine for the same reasons explained above. Considering the most common prevailing conditions, working head on the turbine will be 81 ft. and flow 105 cfs. Generated power will average 650KW.

At the Felícita syphon installation, it is more practical to install a horizontal turbine because for this configuration cavitation phenomena are excluded and the cost of actual construction for powerhouse is very low.

Construction dimensions for the powerhouse as shown in the concept design do not exclude any vendor sources of turbines from competitive bidding to supply the equipment. Their designs may vary as to specific turbine dimensions, which are variable for each manufacturing company, but the design can accommodate any of the current equipment offered by manufacturers listed in Section 7.0.

Using data provided in quotations by manufacturers of small hydropower units, we can conclude that for the Patillas site hydrological and environmental conditions, a completely automatic unit is feasible using proven advanced technology and, therefore, recommended.

3.6 Conclusions (cont'd)

Existing automatic hydropower units are generally described by the following specifications:

1) Intake structure: consisting of a butterfly valve, which is opened by means of hydraulic servomotor and shut by a counterweight, operates as a start and shut-off device. The turbine is started by opening the valve slowly. When the runner's speed of rotation has reached its design level, the alternator is synchronized. The valve is equipped with an hydraulic control backed up by a stored energy (battery) control for emergency closure in the event of power loss. The control mechanism is sized to close the valve against full turbine runaway speed discharge. A butterfly valve is feasible for installation at the Earth Dam and Syphon hydropower plants. For spillway installation, it is necessary to construct an intake gate which is equipped with a similar automatic control device. The valve (or gate) is provided with a releasing device which shuts the valve, in the event of out of tolerance conditions occurring in the generating equipment.

2) Power controls: The turbine's fully automatic operation is assured through a regulator which provides continuous stepless control of the turbine based on inlet water flow and reservoir water level with complete accuracy. Paralleling with the main grid is automatic through a synchronous generator.

The exciter-regulator achieves both generator excitation and accurate voltage regulation for varying conditions of load, power factor, generator frequency, and load imbalance. Excitation power is normally obtained from generator output voltage. Exciter-regulators may be of the static thyristor type, utilizing self-excitation of the generator's own output. Accurate control of generator voltage is achieved through the use of a closed-loop regulating system.

3.6 Conclusions(cont'd)

3) Operating controls: A prescribed automatic operating regime (for peak load operation) may be achieved with automatic timer start & shut down switches.

From these equipment operation specifications, it is inherent that hydropower installations at the Patillas site are conceived for operating safely. They are also flood protected because they will be implemented only at existing hydrotechnical structures(Earth Dam Outlet Structure, Spillway and Syphon).

In Table 3.6, operating profiles are summarized for all three potential phases of hydropower retrofit installation at the Patillas site.

3.7 Estimate of Construction Costs

The work of construction is simple and straightforward. Local construction companies are capable of constructing any phase of it. The costs of construction are based on a survey of local prices in Puerto Rico.

Tables 3.1 and 3.2 tabulate the estimated costs for constructing the hydropower installation at the irrigation outlet structure of the earth dam. Table 3.1 shows the projected costs for the vertical turbine configuration and table 3.2 shows the projected costs for the horizontal turbine configuration.

The estimates include the cost of constructing a cast in place concrete structure to house the power plant, furnishing & installing diversion piping, turbine, generator and controls, construction of connection to the existing irrigation canal, installation and testing of the equipment and, an allowance for engineering design still required.

Outflows from the reservoir are not changed if Phase 1 alone or Phase 1 and Phase 3 are implemented; the existing irriga-

tion flow is simply used to generate power and the irrigation function continues as before. If Phase 2 is implemented, a lowering of the lake surface below current levels is expected to occur part of the time.

3.7.1 Fixed and Variable Costs

Material costs have been verified for all major items. Price quotations have been obtained from four of the nine well established, reputable manufacturers of turbines and generators contacted. Verified fixed costs for equipment and materials to be used in the project account for approximately 50% of the total cost which leaves the 10% allowance for unlisted items and 10% for other contingencies applicable to the variable construction cost items. The project cost estimates are, therefore, believed to be very conservative.

TABLE 3.6 FEASIBLE OPERATING PROFILES

No.	Hydropower Installation	Generating Install. Capacity (KW)		Annual Energy (KWH/YR)	
		24hr/day year 'round	Peak Hr 12hr/day 5day week	24 hr./day year 'round	Peak Hours 12hr/day 5 days/week
1	at earth dam	400	490	3,504,000	1,528,800
2	at Spillway *	---	650	---	2,028,000
3	at Syphon	300	330	2,628,000	1,029,600
Total Phase 1 (1)		400	490	3,504,000	1,528,800
Total Phase 2 (1+2)		400	1140	3,504,000	3,556,900 **
Total Phase 3 (1+2+3)		700	1470	6,132,000	4,586,400

* Operates only for Peak Power Generation

** Probability of failure to deliver stated energy levels: 1.98%

POSSIBLE OPERATING PROFILES FOR PHASE #1
(for single installation)

HYDROPOWER RETROFIT at EARTH IRRIGATION OUTLET STRUCTURE

	24hr/day year/round	peak power 12 hr/day 5 days/wk.
Generating Capacity(KW)	400 *	665 **
Annual Energy(KWH/Yr)	3,504,000	2,074,800

* Working According to current irrigation Release Practice

** Working in Peak Power Generation Strategy
According to Current Power Supply Practice

PEAK HOURS (12H/D; 5D/w)

INSTALLED CAPACITY 900 [illegible]

FAILURES EACH MONTH

KWH/H	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0	0	0	0	0	0	0	0	0	0	0	0
90.00	0	0	0	0	0	0	0	0	0	0	0	0
180.00	0	0	0	0	0	0	0	0	0	0	0	0
270.00	0	0	0	0	0	0	0	0	0	0	0	0
360.00	0	0	0	0	0	0	0	0	0	0	0	0
450.00	0	0	0	0	0	0	0	0	0	0	0	0
540.00	0	0	0	0	0	0	0	0	0	0	0	0
630.00	0	0	0	0	0	0	0	0	0	0	0	0
720.00	0	0	0	0	0	0	0	0	0	0	0	0
810.00	0	0	0	0	0	0	0	0	0	0	0	0
900.00	0	0	0	1	2	0	0	0	0	0	0	0

SPILL EACH MONTH

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	54	18	7	8	32	42	52	58	59	59	59	59
280.80	54	18	7	8	32	42	52	58	59	59	59	59
561.60	54	18	7	8	32	42	52	58	59	59	59	59
842.40	54	18	7	8	32	42	52	58	59	59	59	59
1123.20	54	18	7	8	32	42	52	58	59	59	59	59
1404.00	53	18	7	8	32	41	52	58	59	59	59	57
1684.80	51	18	7	8	31	41	52	56	59	59	59	57
1965.60	47	18	7	8	31	41	52	56	59	59	59	54
2246.40	43	18	7	8	30	40	51	56	59	59	58	52
2527.20	38	18	7	8	29	39	49	55	57	59	56	50
2808.00	33	18	7	8	27	35	46	53	57	57	55	47

PROBABILITY OF FAILURE

MWH/YR	J	F	M	A	M	J	J	A	S	O	N	D
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
280.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
561.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
842.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1123.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1404.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1684.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2246.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2527.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2808.00	0.0	0.0	0.0	0.017	0.034	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4.0 ECONOMIC FEASIBILITY DETERMINATION

4.1 Introduction

The retrofit of Patillas reservoir with a hydroelectric generating facility appears to be economically feasible at this time, based on today's high oil prices and the availability of new technology in control systems. A classical engineering/economic analysis of the proposed earth dam installation for example, indicates that such an investment in hydropower can be expected to:

- -yield better than a 20% rate of return to Puerto Rico.
- -produce energy at less than 2¢ per KWH for at least 30 years.
- -be repaid in less than six (6) years.
- -save over 6000 barrels of oil annually.

Such attractive results would not have been true as recently as ten years ago when oil sold for less than $2/bbl and "state of the art" in automatic controls was not commercially exploited.

In addition to direct cash benefits of the proposed hydropower project are several indirect and/or qualitative considerations:

- -reduced air pollution from oil-fired electric plants (the costs of air pollution can be expected to increase in the future if low-sulfur fuels become scarce.)
- -reduced dependence on uncertain foreign oil supplies and consequently improved balance of payments.
- -reduced use of cooling water at the steam plants.
- -stimulation of local economy during construction.
- -an increment to the Authority's installed generating capacity based on renewable resources.

These latter benefits would be of major significance if aggregated over multiple hydropower installations, where their magnitude would exert a measurable impact on the Puerto Rican economy. For a single facility such as the proposed Patillas plant, however, the dollar value of these secondary economic benefits are sufficiently small that they will be included here only qualitatively. The loss of analytic rigor is not great, because the value of the excluded secondary "ripple" benefits is swamped by the actual cash savings from reduced oil purchases. Therefore, although the economic cost-benefit equation presented in Section 4.4 omits these secondary items for the sake of simplicity, they should be kept in mind by decision-makers.

4.2 The Costs of a Patillas Hydropower Retrofit

There are two types of costs anticipated in the production of electricity at Patillas reservoir: initial, one-time costs to design and build the facility and annual life-long costs to operate and maintain it.

The operation and maintenance costs of a small, modern hydropower plant are trivial based on actual on-line experience with similar equipment elsewhere.[1] The fully automatic controls called for in the engineering design (see Section 3) reduce the likely labor requirement to once-a-month inspection and possible screen cleaning. As there is already an operator on duty at the reservoir who can conveniently take care of these activities, no added cost for operation and maintenance is charged to the hydropower equipment. Similarly, no increase in required maintenance of the existing structures of the dam, canal, spillway, etc. are anticipated as a result of the proposed hydroelectric retrofit.

A detailed estimate of the construction costs for each of the alternative hydropower options possible at Patillas reservoir is provided in the engineering section of this report. These costs are based on design parameters for each configuration and on current prices for labor and equipment as shown (sources include manufacturers' hardware quotes, local prevailing wage rates, etc.). The derivation of project costs set out in Tables 3.1 & 3.2 are self-explanatory and bear only one further comment here. That is the effect of inflation on the cost estimates. All prices quoted are in late-1978 dollars, and can be expected to increase annually if the project is not implemented immediately. Just how quickly project costs go up can be seen in Figure 4.1. There are additional considerations on the timing of project costs & benefits which will be explained in Section 4.4.

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(1) For instance, a fully-automated 502KW hydroelectric facility in Kalsetter, Sweden requires about 3-4 hours of labor per month according to the owner-operator of the installation.

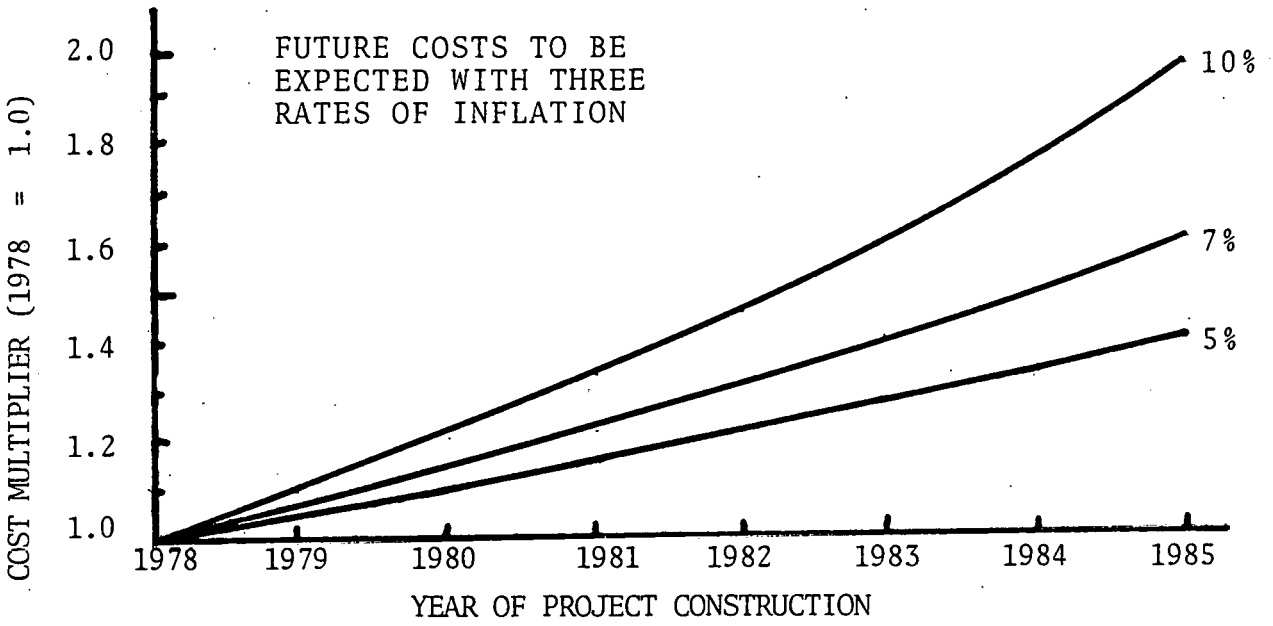

FIGURE 4.1

4.3 Benefits of a Patillas Hydropower Retrofit

Overwhelming the beneficial side-effects of hydroelectric power mentioned earlier, is the potential cash saving from reduced oil imports made possible by hydroelectric power use. In 1978, the WRA spent an average of 2.54¢ per KWH on fuel alone[2], a figure which is sure to go up in the foreseeable future. On this basis, a projected minimum firm energy production of 3.5 million KWHR per year from the earth dam installation alone will yield annual savings on fuel expenditures starting at $89,000 in the first year of operation and going up from there at whatever rate OPEC deems appropriate. (known to be 10% for 1979)

It must be noted that only fuel expense displacement is taken into account as an economic benefit here. Presumably, any change in sales revenue which arises from hydropower implementation, will represent an income redistribution effect among island interests, and not a cost savings for Puerto Rico vis-a-vis the rest of the world. Although the total savings attainable by hydropower are aggregated for purposes of feasibility assessment, it may be of interest to break down the benefits by recipient group.

(2) Bond prospectus dated September 26, 1978 by Merrill Lynch White Weld Capital Markets Group, page 20.

4.3 Benefits of a Patillas Hydropower Retrofit(cont'd)

The ultimate distribution of any fuel cost savings will be island-wide due to the current rate structure of the WRA. It provides that all fuel charges incurred in excess of $2.00 per barrel be passed on directly to the utility's customers, and so, conversely, are any savings in fuel costs. Seventy percent (70%) of the Authority's residential customers are subsidized by the Government Treasury for their fuel surcharge. In aggregate, the benefits from displacing oil with hydropower will accrue to customers approximately in proportion to each sector's electricity purchases. Therefore, for NOT purchasing one barrel of oil costing $14.00, the following groups will save:(3)

Water Resources Authority	-	$2.00
Unsubsidized residences	-	1.20
Government subsidy fund	-	2.64
Industrial customers	-	5.04
Commercial and others	-	3.12

The conclusion to be observed from this benefit distribution breakdown is that the displacement of imported oil as an electricity-generating fuel will benefit many sectors of the Puerto Rican economy under the WRA's current rate structure. However, the WRA will presumably bear the investment cost for a hydropower facility alone. Consequently, it may be necessary for the responsible development agency to offer the WRA some additional incentive (either a greater share of the benefits or a partial subsidy on the initial investment) in order to make the investment a sound one for the utility. The project benefits so far exceed its costs that it would be well worthwhile for the Government of Puerto Rico to do so.

Pursuant to the Authority's mandate to "promote the general welfare of the Commonwealth",(4) all benefits, to whomever they may accrue are included in the mathematical economic analysis presented in the next section.(5)

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(3) Based on 1978 breakdown of electricity sales in Puerto Rico, as reported in Bond Prospectus dated September 26, 1978.

(4) WRA enabling legislation, 1941.

(5) This perspective represents the Puerto Rican government's expressed desire to diversify energy resources and develop the island's renewable energy resources.

4.4 Mathematical Model of Economic Feasibility

Efforts to describe real-world relationships and observations by mathematical formulas have been made in nearly all fields of study. Fortunately, economic analysis lends itself reasonably well to numerical representation, and the key factors in a Patillas hydropower investment fit the classical engineering-economic model of evaluation quite appropriately. In deciding the optimal level of complexity for an economic model, a tradeoff must be made between reality and solvability, as can be shown qualitatively in Figure 4.2.

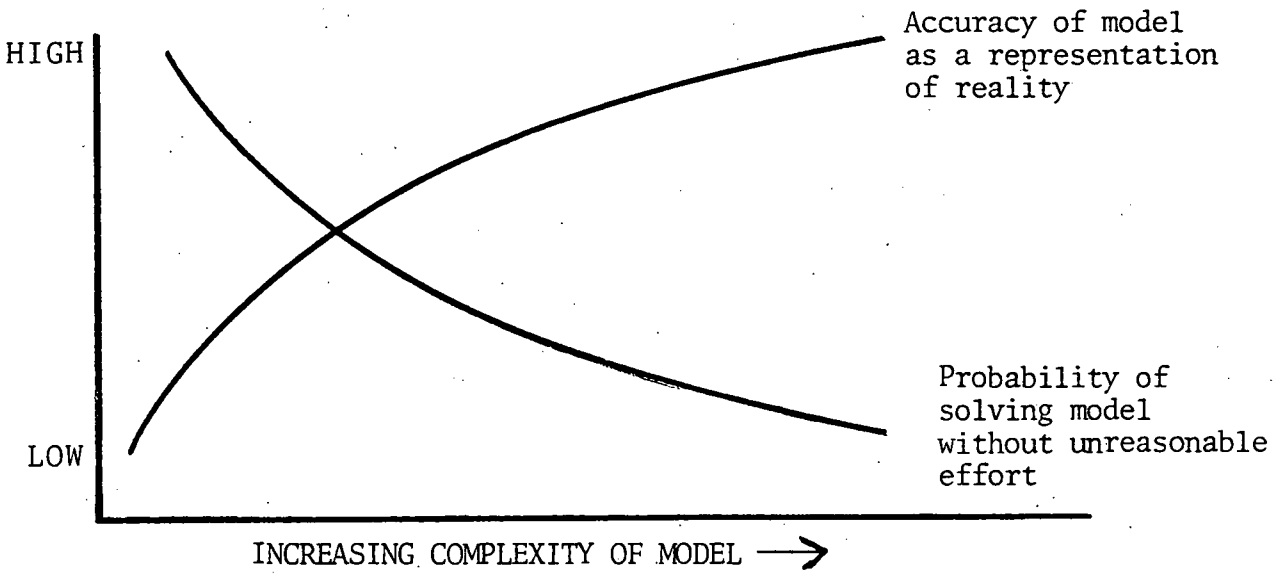

FIGURE 4.2 - Tradeoff in Economic Model Design

The most effective model will lie somewhere in the middle range of complexity, reflecting the most significant aspects of the real world without becoming hopelessly muddled with details which can make the tool unworkable. This compromise underlies the Patillas economic model, which is a general analytical tool for evaluating any one of the proposed hydropower options available at Patillas (or for that matter anywhere in Puerto Rico).

The economic analysis of a hydroelectric retrofit installation by classical engineering-economic techniques involves discounting future cash flows to an equivalent present worth. At some discount rate, called %INT in the accompanying computer model, the

fundamental discounted relationship is:

Present Worth of Initial Investment(including interest)	=	Present worth of a series of future net benefits

It is customary that these costs and benefits be measured in comparison to some alternative course of action. In this analysis, the comparative alternative is assumed to be identical levels of power generation by an oil-fired steam plant. Within this comparative framework, only differences between the two options are relevant to the analysis.

Using the viewpoint of the Government of Puerto Rico, which includes the specific perspective of the Water Resources Authority, the cost-benefit calculation can be expressed verbally:

total installed cost with interest compounded during one-year lead time(6)	=	present worth of thirty years of fuel savings, with allowance for inflation in fuel prices; less expense for operation & maintenance of plant, if any, with allowance for inflation

Or using the symbols defined in the computer printout attached, the mathematical expression is:

$$COST\ (1+\%INT) = \frac{[(KWHR)(.0105)(PF)]}{(\%\uparrow PF - \%INT)} \times \left[(1 + \frac{\%\uparrow PF - \%INT}{1 + \%INT})^{LIFE} - 1\right]$$

$$+ \frac{O\&M}{(\%\uparrow OM - \%INT} \times \left[(1 + \frac{\%\uparrow OM - \%INT}{1 + \%INT})^{LIFE} - 1\right]. \quad (7)$$

The above equation is cumbersome to calculate by hand, but has been conveniently programmed on a small computing calculator. The program is capable of using any values for the equation variables and determining the impact on investment desirability.

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(6) The model formulation assumes that cash outlay for the project will occur as follows: 1/3 @ 12 months before start-up, 1/3 @ 6 months before start-up, 1/3 @ start-up = average total cash exposure of approximately 6 months. Subsequently, each year's benefits are assumed at mid year.

(7) If no real O&M cost is incurred by the hydropower installation, as was suggested in Section 4.2, then the second line of the equation will drop out.

4.4 Mathematical Model of Economic Feasibility(cont'd)

There are two methods of operation available, depending on known information and desired output.

1) If it is known what the investor's minimum acceptable rate of return on this investment is,(plug value in for "%INT"), then the calculator will provide an investment ceiling. That is the maximum dollar investment which can justifiably be made in the system, given predicted levels of power production.

2) Alternatively, if the total installed system cost is known (plug in value for "COST"), then the program will calculate the rate of return realizable on such an investment.

The most valuable aspect of the economic model is its flexibility. It can be implemented for various levels of power production, investment size, operating requirements, hardware life, price levels and inflation rates. The calculated outputs include the number of barrels of oil saved annually, the first year dollar value of the oil saving, the rate of return on investment, the installed cost per kilowatt capacity, and the life cycle cost of hydroelectricity per kilowatthour.

Underlying the model formulation are a number of implicit assumptions which are clarified below:

1. The annual energy produced(KWHR) depends on the operating schedule selected and the level of reliability required by the WRA (see Hydrology & Engineering sections).

2. Electricity sales are assumed to be unaffected by the use of hydropower instead of thermal electric power.

3) Because of the tax-exempt status of WRA, no investment tax credit nor energy tax credit is received by the utility for its hydropower purchase.

4) O&M expenditures relevant to the proposed hydropower retrofit may be entered in the model as either cost(-), a benefit(+) or neutral(0). The implications of a zero entry have been described previously - the attendant already on duty at the dam will take care of the modest O&M requirements of the automatic device. A negative entry for O&M implies that no operator is available at the site presently and some-

one must make a special monthly site visit for inspection and cleaning.

A positive entry for O&M would be appropriate only if multiple hydropower installations were contemplated, such that a reduction in labor at the steam plants could be achieved. The magnitude of such a cost displacement is substantial--on the order of half-a-cent per kilowatthour--based on WRA's current O&M costs(excluding fuel). (8) However, before including any O&M savings at the Authority's steam plants, full ramifications on employment must be recognized.

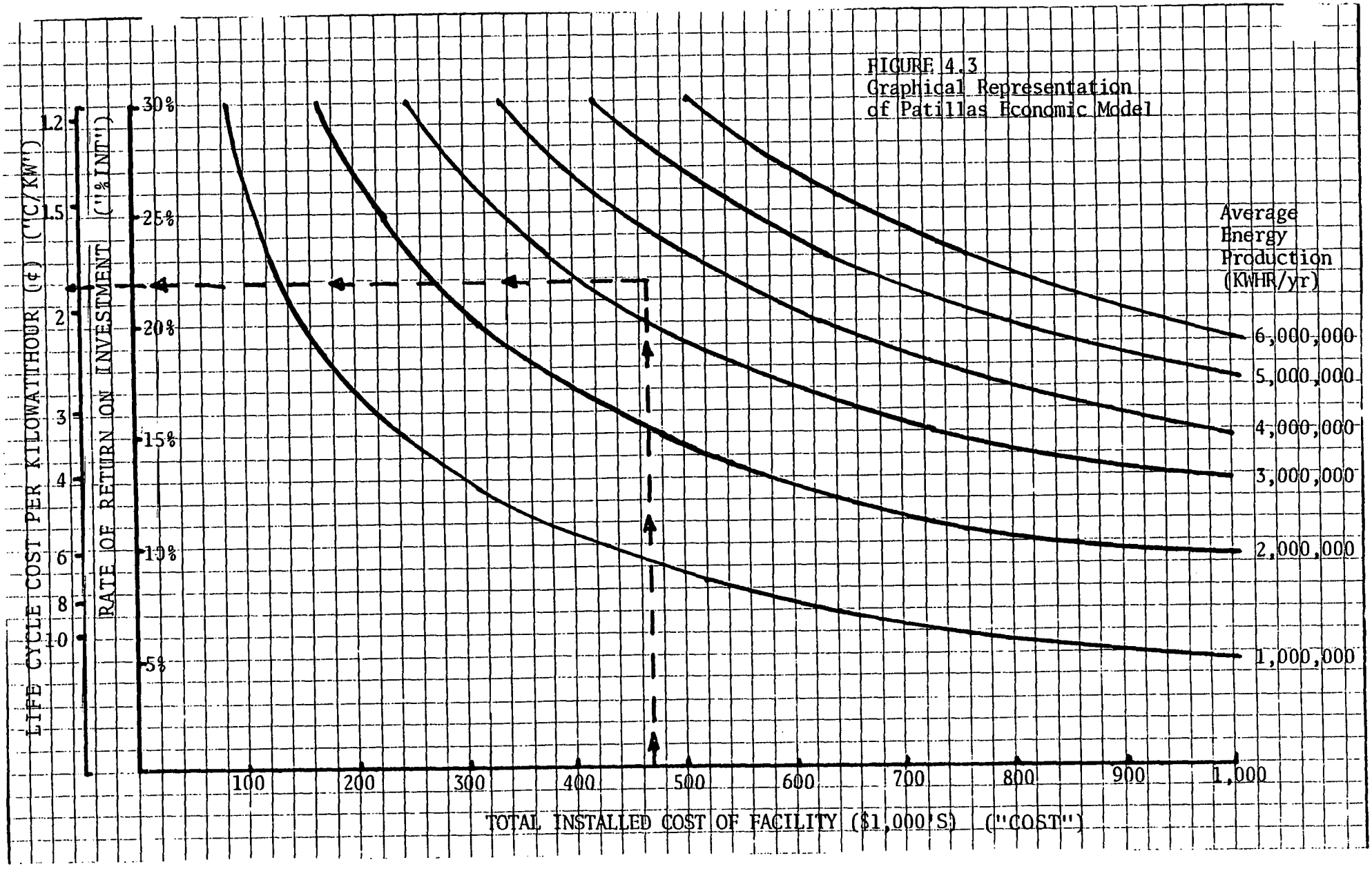
5. No income or property taxes are included in the model. The WRA's "contribution in lieu of taxes" is also omitted because it is simply passed on to customers as an 11% surcharge on their bills, having only a small distributional effect between WRA customers and the Commonwealth, for this analysis.

6. The cost per kilowatthour calculated in the model contains the amortized capital costs of the hydropower facility plus an estimated $100/month for operation and maintenance.(9) The cost of capital is the rate of interest payable on WRA bonds, plus a margin for overhead. The resulting C/KH is extremely sensitive to the selection of this borrowing interest rate (%BOR).

Figure 4.3 illustrates graphically the relationships among several model variables according to the equation presented earlier in this section. The graph permits the same 2-way implementation as the computer program: either COST or %INT may be input (by entering on the horizontal or vertical axis, respectively), and an energy production level assumed (by selecting the appropriate KWHR-curve), in order

(8) In 1978, the WRA spent $74,888,000 on "production" and "maintenance" for an energy output of 13,685,000MWHR, an average of .55¢/KWH , as compared to projected 0.03¢/KWH for hydropower O&M.

(9) The $100/month O&M figure is included as the most conservative of the three possible O&M impacts described in item #4. This is not a program variable for this particular calculation, but its effect is very slight, on the order of 0.03¢/KWH.



The curves shown above illustrate the relationship between initial system investment and the expected rate of return for various levels of energy output. For a 2-dimensional display several model variables must be assumed fixed: project life = 30 years, operation & maintenance = 0, price of fuel = $2.40/MMBTU, annual rate of fuel price increase = 7%. The dashed line illustrates the earth dam option as base power.

4.4 Mathematical Model of Economic Feasibility (cont'd)

to obtain either the rate of return or investment ceiling (by reading off the value on the remaining axis). The leading candidate site, at the earth dam, is sketched onto the graph. The constant values underlying the shape of these curves are given; any variation in these fixed items will require that a new graph be plotted. It is the computer's ability to vary all input values simultaneously that makes it superior to the graphical analysis shown here.

4.5 Results of the Economic Analysis

Figure 4.4 displays a sample output from the programmed economic model, with definitions of all model variables given. The example used for demonstration is that of the earth dam installation operating on a 24/hour-a-day schedule. Additional iterations of the program have been completed, using data representative of each possible operating strategy. The results are summarized in tabular form by Figure 4.5.

FIGURE 4.4 SAMPLE COMPUTER PRINTOUT OF PATILLAS ECONOMIC MODEL

```
PATILLAS

  DATA

        1.      SITE  = Site key: 1-earth dam; 2-syphon; 3-spillway
      665.        KW  = Installed capacity recommended by engineers(KW)
  3504000.      KWHR  = Avg. annual energy output from hydrologic analysis(kwhrs)
     2.36        PF   = Current price of fuel to Commonwealth ($/MBTU)
     0.07      %↑PF   = Annual rate of fuel price increase(uniform over life)
       0.       O+M   = First year change  in O&M over like-sized thermal plant
     0.07      %↑OM   = Annual rate of O&M cost increase (uniform over life)
       30.     LIFE   = Decision time horizon or expected life of facility(yrs)
   470000.     COST   = Total installed project cost, if known($) *
     0.12      %BOR   = Rate of interest on  WRA bonds and overhead margin

                        *otherwise, omit COST & print %INT, a given minimum
                         required return (%).

  CALCULATIONS

6343.448276     BBLS  = Avg. number of barrels of oil per year displaced
   86829.12     VALU  = First year oil savings ($)
   86829.12     TOTL  = First year total savings ($)
.2181868453     %INT  = Discounted rate of return on investment(%) if COST known*
706.7669173     D/KW  = Capital investment per installed kilowatt($/KW)
1.899235769     C/KH  = Total cost per kilowatt(¢/kwhr)

                        *otherwise, omit %INT and calculate maximum justifiable
                         investment (COST) for given required rate of return.
```

Additional notes:

The installed capacity of 665 KW is maximum--the project proposed can produce variable power outputs up to that level.

The calculation of C/KH is extremely sensitive to the value used for %BOR.

FIGURE 4.5 SUMMARY of ECONOMIC FEASIBILITY of SELECTED INSTALLATIONS & OPERATING SCHEDULES

Site & Schedule	KW[b]	KWHR	COST	The values for PF, %PF, O&M, %OM, LIFE, and %BOR are assumed to be the same for all operating configurations at the values shown in Figure 4.4	BBLS	VALU[c]	%INT	D/KW[c]	C/KH
Earth Dam Base Power[a]	665	3,504,000	$470,000		6343	$ 86,829	21.8%	$ 707	1.9¢
Earth Dam Peaking Power[a]	665	2,074,800	470,000		3756	51,414	15.6%	707	3.2¢
Earth dam + Spillway Peaking Power	1315	3,556,800	1,040,000		6439	88,138	13.0%	791	4.1¢
Earth dam + Syphon Base Power	995	6,132,000	1,860,000		11,101	151,951	12.5%	1869	4.3¢
Earth dam + Spillway + Syphon, Peaking	1645	4,586,400	2,430,000		8,302	113,651	8.3%	1477	7.5¢

(a) "Base Power" is 24 hrs/day, 365 days/year on-line
"Peak Power is 12 hrs/day, 5 days/week on-line

(b) For definition of variables, see Figure 4.4

(c) For an important discussion of these figures, see Section 4.5 of text

4.5 Results of the Economic Analysis(cont'd)

Two important qualifications must be made on the results summarized in Figure 4.5. The first concerns the valuation of electricity produced during peak hours versus that produced continuously. Underlying the table entries is an across-the-board value of $2.36 per million BTUs[10] for all displaced fuel. It may very well be that in reality the displacement of peaking power (i.e. gas turbines in Puerto Rico) is much more valuable than reducing baseline energy from the steam plant. Therefore, even though the cost per kilowatthour shown in the last column is higher for the peaking applications, the value which the Authority places on such power may more than compensate for the difference.

The second qualification to be made is the calculation of cost per kilowatt installed capacity. This figure is based upon each installation's maximum power output; does not reflect level of utilization. Therefore, a large unit which is underutilized will have a low cost per KW whereas a smaller unit fully utilized will have a high cost per KW. Not only are these $/KW values poor indicators of relative attractiveness among hydroelectric facilities, they may be very misleading if used for comparison to other types of generating capacity. Obviously, a fossil or nuclear fired system which costs $1000/KW to install but requires expensive fuel input thereafter is not equivalent to a hydroelectric plant costing $1000/KW to install with free "fuel". A more comprehensive evaluation of any energy source is either the life-cycle cost per kilowatthour (C/KH) or the rate of return on investment(%INT). [These qualifying remarks are applicable generally to economic analysis of energy alternatives and are not confined to this particular model.]

In conclusion, utilization of the earth dam site as full-time generating facility looks very attractive at this time.

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(10) WRA's average cost for fuel in 1978, according to Bond Prospectus dated September 26, 1978.

4.5 Results of the Economic Analysis(cont'd)

Furthermore, all the other options except the triple-peaking facility compare favorably with the WRA's average system bus bar cost of 5.36¢/KWH. However, determination of actual operating schedule to optimize use of the Patillas facility will depend on detailed cost data for peaking power, unavailable for this analysis.

5.0 REPORT OF ENVIRONMENTAL CONDITIONS AT PATILLAS RESERVOIR AND AN EVALUATION OF POSSIBLE EFFECTS OF SMALL HYDROPOWER DEVELOPMENT

5.1 Introduction

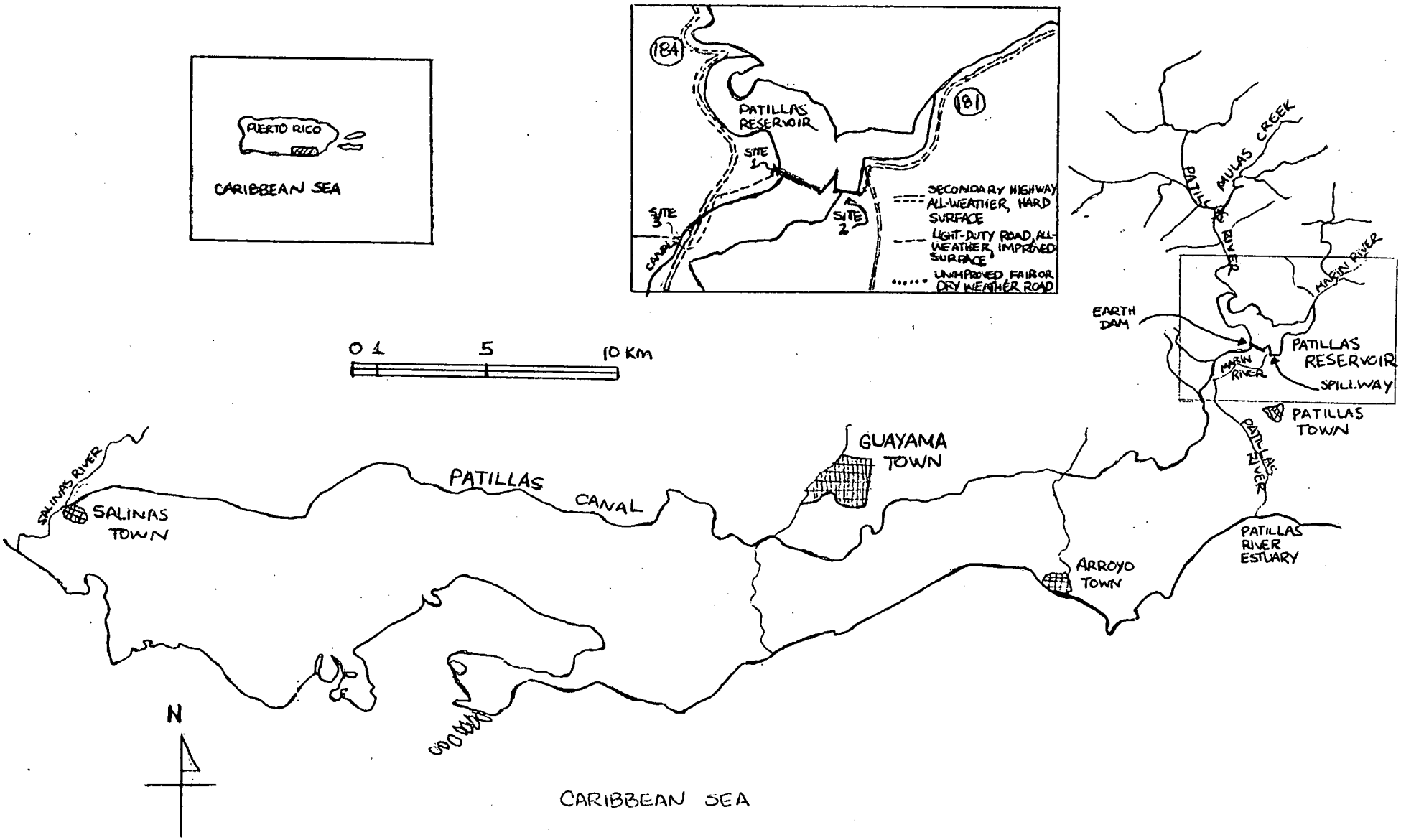
This report assesses important ecological conditions at and in the vicinity of Patillas Reservoir in Puerto Rico and considers environmental effects of developing the site for small-scale hydroelectric power generation. The proposed power generation options are designed to fit into existing reservoir-use schemes, and it is therefore unlikely that hydropower development at the Patillas site will cause significant ecological disruption. The source of much of the information contained in this report is a study of the baseline conditions at Patillas Reservoir by W. R. Jobin of the University of Puerto Rico's Center for Energy and Environment Research (see References). The CEER has also made an assessment of possible environmental effects of small hydropower retrofit at Patillas Reservoir.

5.2 Description and Uses of the Patillas Region

Patillas Reservoir is located on Puerto Rico's southeast coast (see Figure 5.1). The reservoir sits about 5 km (3.1 mi.) inland in a sparsely populated, hilly (40-60% slopes) watershed partially covered with lush vegetation. Cattle graze on cleared pastures interspersed through the natural plant cover. Geologically, the reservoir lies in a complex of volcanic and plutonic rock of Cretaceous/Tertiary origin. Soils in the mountains above the lake are poorly developed and lack clay horizons (Inceptisols of the Mucara y Naranjito group), while the soils of the alluviated plain downstream are fertile Entisols (Albion group). According to Federal and local lists, no endangered plants or animals inhabit the Patillas Reservoir area. Populations of snails, fish, turtles, and birds are supported by the reservoir.

The area experiences definite rainy (August - December) and dry (January - July) seasons. Patillas Reservoir receives about

Figure 5.1. Map showing location of Patillas Reservoir, Patillas Canal, and details of the area.



1300-1500 mm (50-60 in.) of rain annually, while the contributing watershed to the north receives 2300 mm (90 in.). During dry months in the past substantial drawdown on Patillas Reservoir has occurred for irrigation of downstream sugar cane fields. In recent years the closing of several cane mills has helped keep water levels high due to decreased irrigation demand. Despite the reduction in sugar cane production, it is planned that the land served by Patillas Canal will continue to be used for agriculture, and thus will require irrigation supplies. Future new crops may include rice and vegetables, both of which use more water than sugar cane. At present, pilot vegetable plots are under cultivation. Conflicting reports have been heard about the possible re-emergence of sugar cane cultivation in the area. The conflict focuses on short versus long-term plans and growers' appreciation of sugar prices on the world market.

At present, water impounded in the reservoir from the Patillas and Marin Rivers must also meet downstream flood control, municipal, and livestock requirements. Necessary water is released directly from the base of the earthfill dam into the Patillas Canal, which, for a short distance, follows the natural course of the Patillas River. The 42 km (26 mi.) canal serves the Puerto Rican South Coast from the reservoir west to Salinas; no water from other sources joins the canal along the way, although Carite Reservoir (north of Guayama) also provides regional supplies. Irrigation water is delivered to holding ponds adjacent to the canal, while livestock are watered directly from the canal. About 5% of Patillas Canal is concrete-lined - mostly along curves to prevent erosion and through towns to prevent scouring with consequent flood threat.

Surplus flows exit Patillas Reservoir into the bed of the Marin River via a spillway east of the earthdam. The existing spillway was completed in 1976 and has apparently contributed to present reservoir level stability. Spillage flows about 1/2 km (0.3 mi.) downstream, then enters the pre-canal bed of the Patillas River. This flow reaches an estuary on the coast about 7 km (4.3 mi.) after leaving the reservoir.

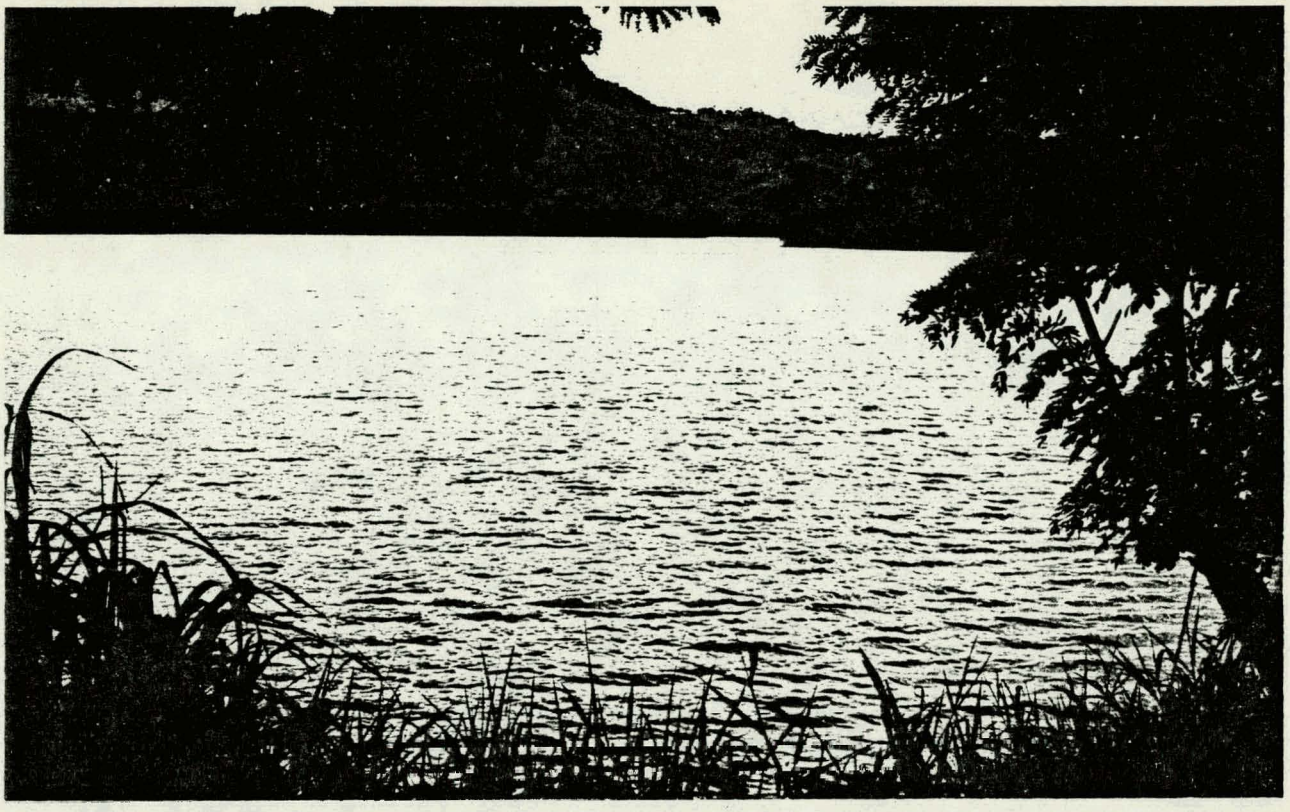
5.3 Ecological Concerns

5.3.1 Bilharzia Control

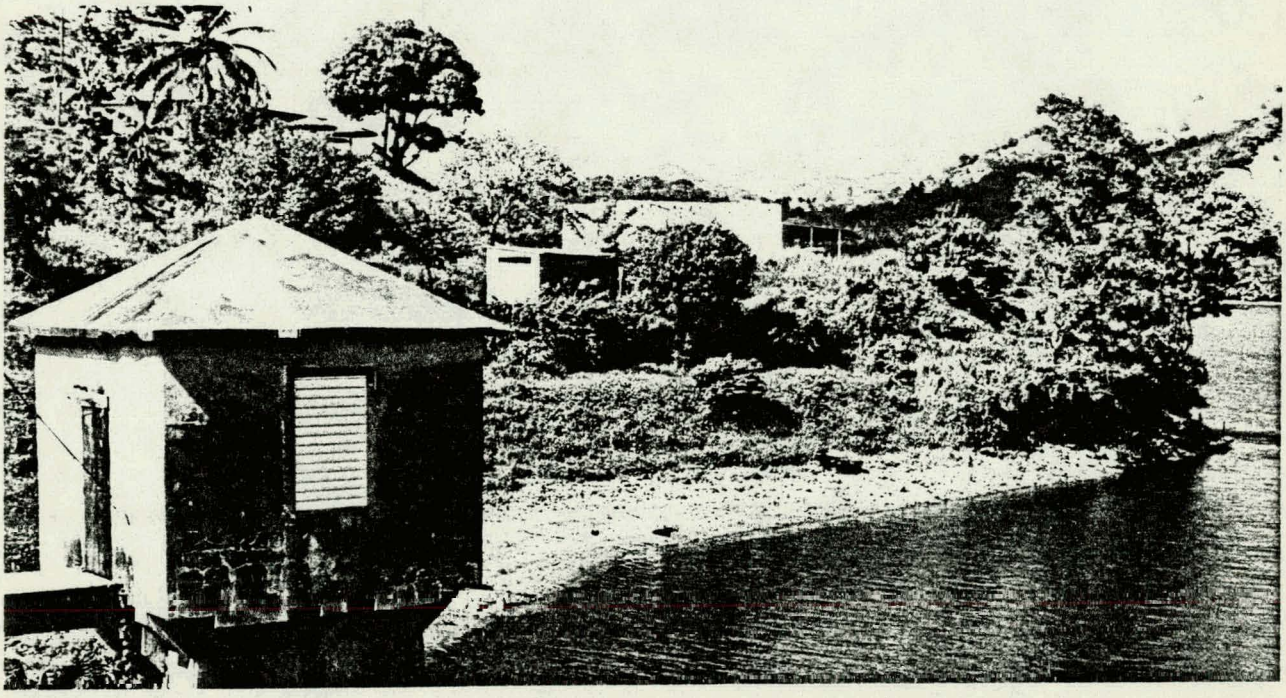
In conjunction with the delivery of appropriate amounts of water to downstream consumers, an important management consideration at the Patillas site is keeping the bilharzia-carrying snail, Biomphalaria glabrata, out of the reservoir. Impoundment of water behind Patillas Dam in 1914 invited the snail to invade an unoccupied expanse of its preferred habitat (shaded, shallow, standing water), and subsequently the disease broke out in downstream canals and sugar cane fields, as well as upstream of the reservoir. Bilharzia (Schistosomiasis) is carried by a worm (Schistosoma) which lives in the intestines and bladders of mammals. If Schistosoma eggs are excreted into water they quickly hatch into free-swimming larvae which then burrow into appropriate hosts. Once in the snails, larvae produce another free-swimming form which can penetrate mammalian skin.

Presently Biomphalaria populations have been eliminated from Patillas Reservoir as a result of chemical control programs in flowing waters and the introduction of the snail Marisa cornuarietus to the reservoir. This snail eats both the eggs and young of the bilharzia intermediate host and competes with adults for other food items. Two other snail species also compete with or prey upon Biomphalaria in Patillas Reservoir, although one of them, the exotic Tarebia granifera, is known to carry a human lung fluke. In October 1978, no floating vegetation, a correlate with Biomphalaria occurrence, was found in the reservoir.

The long-term stability of species interactions in this recently composed snail community is questionable without human interference. Biomphalaria populations are known to fluctuate drastically and are also known to coexist with Marisa in Venezuelan streams where both species occur naturally. However, the local control program has been effective even through reservoir water level fluctuations. The October 1978 survey reported zero Biomphalaria glabrata in Patillas Reservoir but some upstream in the Patillas River tributary



Though placed in a beautiful setting, Lago Patillas attracts few boaters or fishermen, because its waters are not very clear, odor-free or productive (of fish).



Fluctuating water levels in the lake could have an unfavorable impact on the incidence of Bilharzia, but hydropower development is not seen as causing such fluctuations.

Mulas Creek. The activities of humans upstream are obviously an important consideration in the disease control program.

5.3.2 Patillas Reservoir as a Fishery

Patillas Reservoir attracts few recreational boaters and fishermen. The lake is free of harmful pollutants, with chemistry about average for a Puerto Rican Reservoir (Table 5.1), but its waters are not very clear, odor-free, or productive. There is no expressed interest in developing the lake as a recreational or commercial fishery.

There are two probable explanations for the reservoir's poor standing as a fishery. First, nutrient levels (especially nitrates) in the lake are low (see Table 5.1). This factor limits primary productivity. In tropical environments, nutrients tend to remain tied up in lush terrestrial vegetation. Little litter accumulates in these warm, moist areas because decomposition occurs rapidly. Thus few nutrients are available to reach a lake via runoff. In some areas uses of adjacent land enhance the nutrient content of runoff, but this appears not to be the case at Patillas. Low productivity affects not only the food supply of aquatic organisms but also oxygen supply, since O_2 compensation through photosynthesis is limited.

Fluctuating reservoir levels have provided a second major source of stress to the biota of Patillas Reservoir. For fish, these fluctuations represent not only a periodic shrinking of foraging volume, but also the unreliable presence of breeding habitat. Currently five species of standing water fish inhabit the lake: Tilapia mossambica, Cichla oceallaris, Ictalurus nebulosus, Lepomis macrochirus, and Gobiomorus dormitor. Tilapia, Ictalurus, and Lepomis require shallow, protected spawning or nesting sites. Ictalurus and Lepomis spawn in the spring (the traditional time of irrigation drawdown on the lake) when much of the suitable breeding habitat may be exposed. Tilapia exhibits a spawning boom at the start of the rainy season and is the most common fish in the reservoir. Tilapia's success in this and other disturbed bodies of water is attributable to several other factors, as well. This species,

TABLE 5.1. Water quality characteristics of major lakes in Puerto Rico. Measurements represent 1975-1978 and were taken at 0.5 m (1.6 ft.) below the surface of each lake.

	CHLORIDES IN MG/L	HARDNESS AS $MgSO_4$ IN MG/L	TOTAL PHOSPHATES AS P IN MG/L	NITRATES AND NITRITES AS N IN MG/L	IRON IN MG/L	TURBIDITY IN STANDARD UNITS	COLOR IN STANDARD UNITS	PH	DISSOLVED OXYGEN IN MG/L	CHLOROPHYL A IN MG/L	GEOMETRIC MEAN COLIFORM PER 100 ML
Caonillas	5.9 ± 2.7	112 ± 21	0.01 ± 0.01	0.07 ± 0.06	0.15 ± 0.19	3.1 ± 3.7	13.0 ± 4.2	7.42 ± 0.50	7.3 ± 1.5	25.7 ± 15.7	1,919 ± 11
Carite	7.7 ± 2.2	29 ± 16	0.01 ± 0.01	0.03 ± 0.03	0.16 ± 0.14	3.2 ± 0.6	9.8 ± 0.7	7.18 ± 0.16	7.0 ± 0.6		155 ± 3
Carraizo	16.6 ± 4.1	126 ± 23	0.28 ± 0.33	0.33 ± 0.48	1.02 ± 1.11	18.3 ± 15.6	23.0 ± 10.1	7.24 ± 0.25	4.4 ± 1.8	12.9 ± 9.8	17,604 ± 34
Cidra	14.2 ± 0.4	76 ± 0	0.02 ± 0.02	0.20 ± 0.11	0.56 ± 0.27	1.7 ± 1.5	8.2 ± 2.4	7.3 ± 0.23	5.6 ± 0.8		546 ± 6
Dos Bocas	5.8 ± 1.6	97 ± 20	0.01 ± 0.01	0.15 ± 0.15	0.47 ± 0.59	8.4 ± 7.7	15.4 ± 14.0	7.38 ± 0.31	8.2 ± 1.9	2.6 ± 2.4	60 ± 22
Carzas	3.2 ± 2.5	101 ± 93	0.07 ± 0.29	0.06 ± 0.04	0.05 ± 0.06	1.0 ± 1.1	8.5 ± 2.2	7.62 ± 0.29	6.8 ± 1.0		47 ± 56
Guajataca	6.6 ± 5.8	224 ± 64	0.01 ± 0.00	0.47 ± 0.53	0.11 ± 0.09	7.6 ± 5.5	8.4 ± 3.4	7.36 ± 0.49	7.6 ± 0.3		
Guayo	7.6 ± 4.7	110 ± 34	0.02 ± 0.03	0.28 ± 0.53	0.12 ± 0.23	2.7 ± 4.3	11.1 ± 1.8	7.63 ± 0.34	7.6 ± 0.9	7.1 ± 4.0	939 ± 14
Matrullas	2.0 ± 1.4	21 ± 0	0.01 ± 0.00	0.53 ± 0.67	0.22 ± 0.04	1.8 ± 0.2	17.5 ± 10.6	7.85 ± 0.07			
Patillas	9.6 ± 3.1	29 ± 17	0.01 ± 0.01	0.14 ± 0.19	0.07 ± 0.10	9.6 ± 6.3	10.6 ± 2.0	7.72 ± 0.30	7.4 ± 0.7	0.011*	
Prieto	4.4 ± 3.2	157 ± 29	0.02 ± 0.02	0.29 ± 0.26	0.91 ± 1.30	25.3 ± 28.9	13.8 ± 5.9	7.44 ± 0.31	6.4 ± 2.2		2,704 ± 16
Toro	5.0 ± 7.0	137 ± 2	0.01 ± 0.00	0.38 ± 0.09	1.30 ± 0.00	10.6 ± 0.0	10.0 ± 7.1	7.30 ± 0.71			
Means for all Lakes	7.4	101	0.04	0.25	0.42	7.8	12.6	7.5	6.8	12.0	615

* 1975-1976

MEAN CHLOROPHYL INCLUDING PATILLAS = 9.66 MG/L

introduced from East Africa, has had little trouble becoming established throughout tropical America. It thrives in fresh to brackish waters, tolerates temperature instability, and can breed year-around. Instead of incubating eggs in nests, Tilapia females are mouth brooders which carry their eggs around with them. This adaptation may reduce the risk of egg mortality from predation and other bottom disturbances. Ictalurus, Cichla, and Gobiomorus also share with Tilapia a reputation as weedy species (fish which survive and reproduce well in disturbed areas). Cichla and Gobiomorus are voracious fish eaters, so their presence depends on the ability of the other fish with more generalized diets to persist in Patillas Reservoir.

Decreased downstream irrigation and the new spillway have begun to stabilize lake levels. Continued reduced drawdown might attract more "desirable" fish species to the reservoir (although the weedy Tilapia is reputedly excellent eating) and push the disequilibrium fish community toward equilibrium. However, increased municipal, livestock, and irrigation water demand of growing downstream human populations could counter the present trend toward reservoir level stability.

5.3.3 Dissolved Oxygen Content of Patillas Reservoir and Downstream Waters

The dissolved oxygen content of a body of water determines to a great extent the ability of aquatic animals to inhabit it. In Patillas Reservoir, dissolved oxygen drops off at 5m (16.4 ft.) below the surface from near saturation (temperature-specific) to near zero ppm (Table 5.2). The lack of oxygen deep in the reservoir is a function of: a) respiration, particularly of decomposers working on accumulated organic matter on the bottom, and b) darkness, which prevents any oxygen compensation through photosynthesis. Algae in the surface layer and suspended material prevent light penetration into the depths of the reservoir.

Water flowing into the irrigation canal presently contains no dissolved oxygen, since the inlet at the base of the earthfill dam lies well below the oxygenated layer near the reservoir surface.

TABLE 5.2. Dissolved oxygen profile for Patillas Reservoir. Samples taken from four locations on two summer days.

DEPTH M (ft.)	SAMPLE SIZE	$\bar{X}$ DISSOLVED OXYGEN (PPM)	STANDARD ERROR
0 (0)	7	7.2	0.3
1 (3.28)	7	6.7	1.0
2 (6.56)	7	6.8	0.2
3 (9.84)	6	6.8	0.2
4 (13.12)	5	6.9	0.2
5 (16.40)	4	5.6	1.3
6 (19.68)	4	1.8	1.5
7 (22.96)	4	0.6	0.3
8 (26.24)	4	0.3	0.1
9 (29.52)	4	0.2	0.1
10 (32.80)	2	0.1	0.1

As water flows 42 km (26.1 mi.) through the shallow canal toward the ocean, it absorbs oxygen from the air. Algae blooms and emergent vegetation are visible in the canal, and local residents report some fish. Fishing, however, appears worthwhile only in a mangrove swamp near Salinas fed by canal flow.

Water leaves the reservoir over the spillway when the reservoir level reaches 68 m (222 ft.) above sea level. Spillway discharges come from the well oxygenated reservoir surface, and the spilling process can add more oxygen if the water is not already saturated. Thus the riverbed downstream from the reservoir receives only oxygen-rich water when the spillway is operating and no water at other times of the year when the reservoir level is below 68 m (222 ft.) elevation.

5.4 Environmental Effects of Hydropower Development

The direct environmental effects of converting a location on stream into a power generating station are significant. Important biological changes result from: a) the creation of totally new habitat (the reservoir) upstream from the dam and, b) alteration of water quality and quantity downstream from the dam. At the Patillas site the bilharzia problem, struggling fish community, and low levels of dissolved oxygen in the canal are all consequences of dam construction and outlet operation. However, adding hydro-electric turbines to the existing system should result in minimal new environmental disruption at the site. The direct effects of introducing turbines will depend mainly on how the operation changes the quantity of water leaving the reservoir for delivery downstream.

Indirectly, the effects of displacing power generation from another facility are also consequences of hydropower development. In the Patillas case, the amount of power is small relative to steam plant output, and it is doubtful that the power plants would cut back if the hydropower retrofit became reality. Multiple-site hydropower implementation could result in reduced water usage and air pollution from oil-fired steam plant operation. The island of

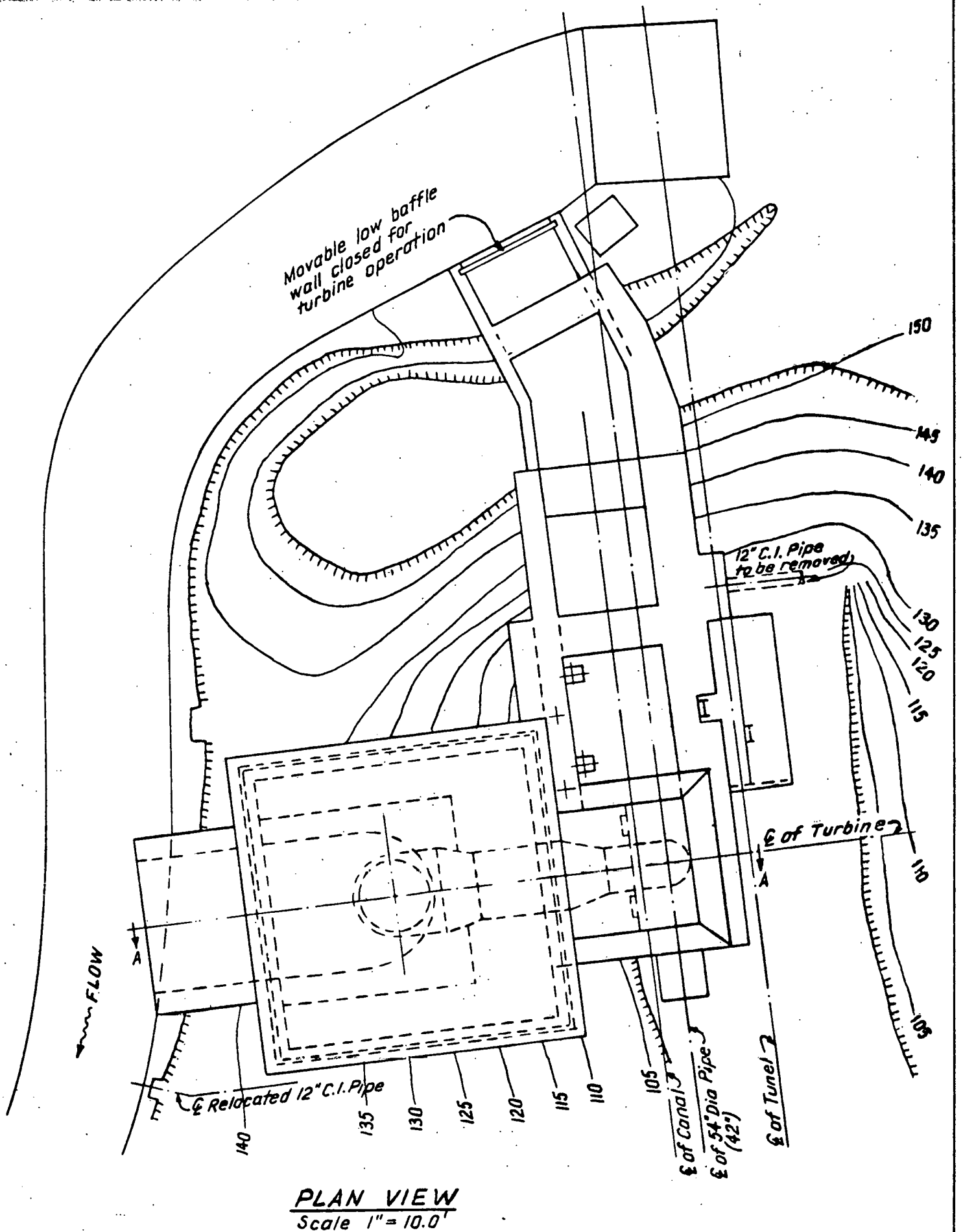
Puerto Rico has localized pollution problems despite its wind and rain regimes, and air pollution, especially, will become increasingly serious as low-sulfur oil becomes more difficult to acquire. The cost of paying for either effective pollution control devices or health impairment, natural ecosystem and crop damage, and loss of tourism becomes a significant decision-making consideration.

At Patillas, three locations are being considered for turbine installation: 1) at the earth dam base irrigation outlet; 2) adjacent to the spillway, and 3) prior to a siphon 2400 m (1.4 mi.) downstream in the irrigation canal. Power can be generated at two of these sites (1 and 3) using existing outflows. The spillway turbine site would draw in water from below the spillway gate release level of 68 m (222 ft.). The following three sections consider the possible environmental effects of turbines at each of the installations, though site 1 at present looks most attractive. When it becomes economically feasible, hydropower facilities can be installed and operated at sites 2 and 3 without interfering with generation at site 1. It is anticipated that hydropower development at any of these sites will cause very little new environmental disturbance.

5.4.1 Site 1: Irrigation Outflow

Presently a 1.37 m (54 in.) diameter pipe draws water through the bottom of the dam. Water is raised in an uptake shaft to the level of the irrigation canal, then sent downstream. Figure 5.2 depicts the existing facilities for irrigation water delivery at the dam along with the proposed hydropower installation. The hydropower retrofit uses the same intake and simply runs irrigation water through a turbine before it heads downstream.

The main environmental concerns relative to the turbine installation at the irrigation outflow are whether such development will alter: 1) amounts of water currently delivered downstream; 2) the existing numerical dominance of Biomphalaria competitors/predators in the reservoir; 3) fishing in the lake, and 4) dissolved oxygen levels in the canal. The economic analysis for this site assumes



PLAN VIEW
Scale 1" = 10.0'

FIGURE 5.2.1. RETROFIT HYDROPOWER INSTALLATION at EARTH DAM OUTLET STRUCTURE VERTICAL TURBINE CONFIGURATION

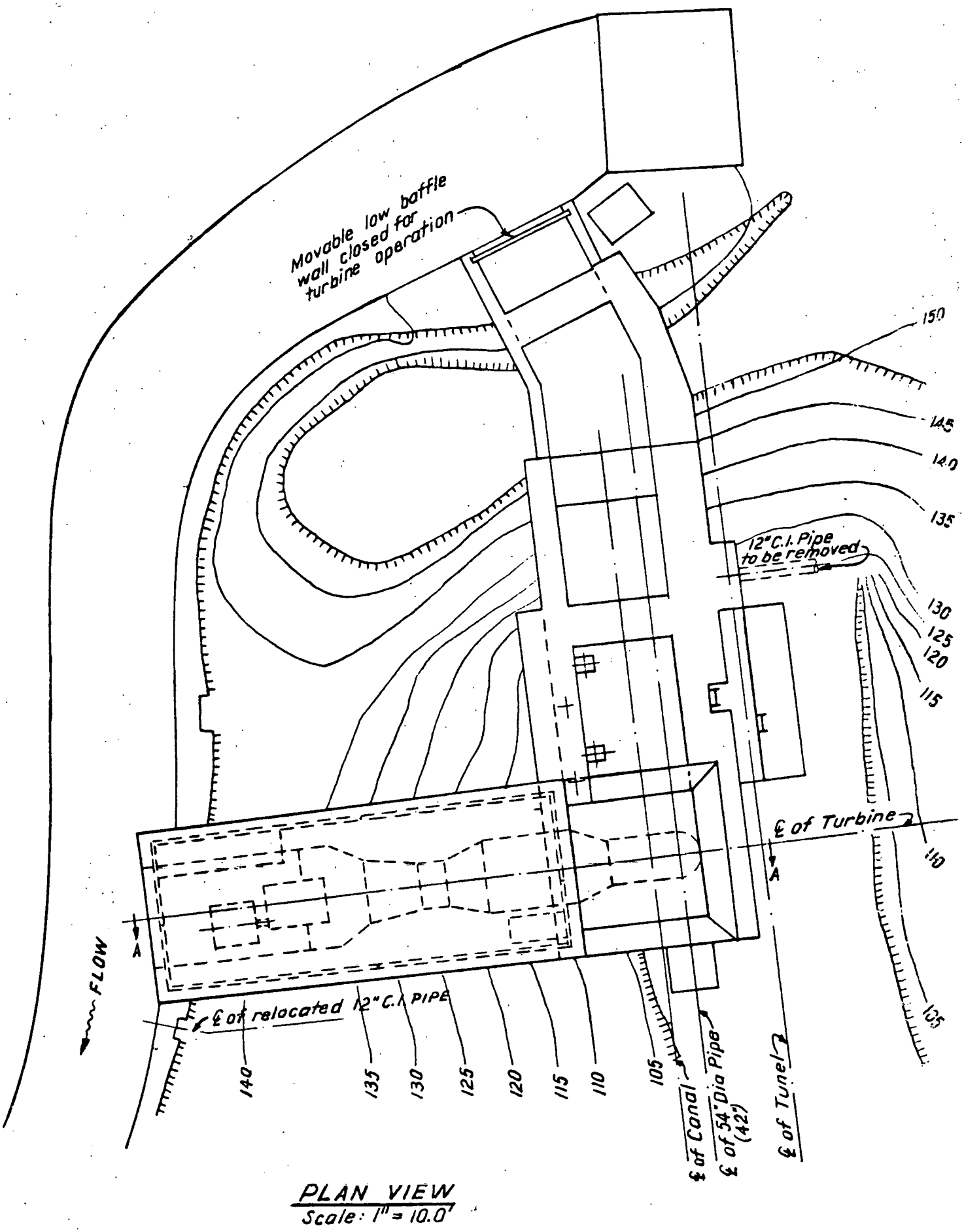


FIGURE 5.2.2 RETROFIT HYDROPOWER INSTALLATION AT EARTH DAM OUTLET STRUCTURE HORIZONTAL TURBINE CONFIGURATION

that power will be generated from irrigation outflows of the same magnitude as in the past. Within this context downstream delivery is insured and lake level fluctuations should not exceed past severity (68 m - 58 m elev. or 14,000-5,500 AF). Nothing is foreseen as a result of the hydropower facility which will cause a renewed outbreak of bilharzia, especially if the reservoir will be monitored frequently and control programs maintained. The assemblage of weedy fish species should not be affected given similar drawdown schedules as previously (and the species composition would probably only shift more towards Tilapia if fluctuations increased).

Water released from the dam into the irrigation canal will continue to contain no dissolved oxygen. If fishing in the canal immediately below the dam were an important concern, the implementation of available technology for aerating water as it passes through turbines would be a consideration. Deoxygenated water does, however, have the advantage of causing minimal corrosion to metal parts.

Some types of turbines could introduce minute amounts of lubricating oil to downstream waters if they are not maintained, but not enough to pose a health threat. The danger of fish mortality from the turbines (and turbine mortality from fish) is decreased by a trash rack covering the irrigation intake. Young fish could pass through this barrier, but such occurrences are highly improbable since fish tend to forage in the oxygenated shallows. The intake lies 24 m (78.5 ft.) below the surface of the full reservoir.

Disruption of the site during construction should be minimal, but some increases in downstream turbidity from ground disturbances and pollution of the area by human activities are likely. Very little vegetation should require removal to gain access to the site; a paved road currently runs along the west side of the lake, and a short ($<$1 km) "improved surface" road connects it with the dam (see map, Figure 5.1). The proposed powerhouse would be built next to the road on the west end of the earthfill dam. Water can

be delivered downstream during construction and (later during turbine maintenance) through the existing irrigation system; the powerhouse will deliver turbine tailwater to the canal via a new conduit which will be opened when the project is completed.

5.4.2 Site 2: Spillway

The major environmental concerns at the spillway are similar to those at the irrigation outflow. Presently the spillway operates when the lake level reaches 68 m (222 ft.) elevation. The proposed turbine intake would draw water at 59 m (193 ft.) from a pipe adjacent to the spillway as demonstrated by Figure 5.3. This turbine would operate only after existing irrigation, municipal, and livestock needs were met, which means almost exclusively during the rainy season when the spillway normally functions (up to 7 months per year). The feasibility of hydropower development at this location is based on the use of only the amount of water which spills annually. Theoretically, then, the turbine would generate power only when the reservoir is full and would otherwise be spilling.

Because it draws only surplus water, the spillway hydropower facility is not predicted to disrupt the current ecological status of the reservoir. No change in drawdown should guarantee no change in the favorability of the lake as Marisa habitat. If the reservoir is monitored frequently for Biomphalaria and control programs are continued, the bilharzia carriers should not be any greater problem in the reservoir after installation than they currently are. The fish community is composed of weedy refugees because of existing lake level fluctuations; again no new fluctuations are expected from power generation at the spillway to add to the stress. The use of the annual spillage amount to generate power also maintains seasonal river flows for fishing and bathing by downstream residents.

Currently all spillway discharges are well oxygenated. Turbine installation adjacent to the spillway would not change this situation. The spillway turbine is designed to draw water from 9 m (29.5 ft.) below the capacity reservoir surface. (See Figure 5.3.)

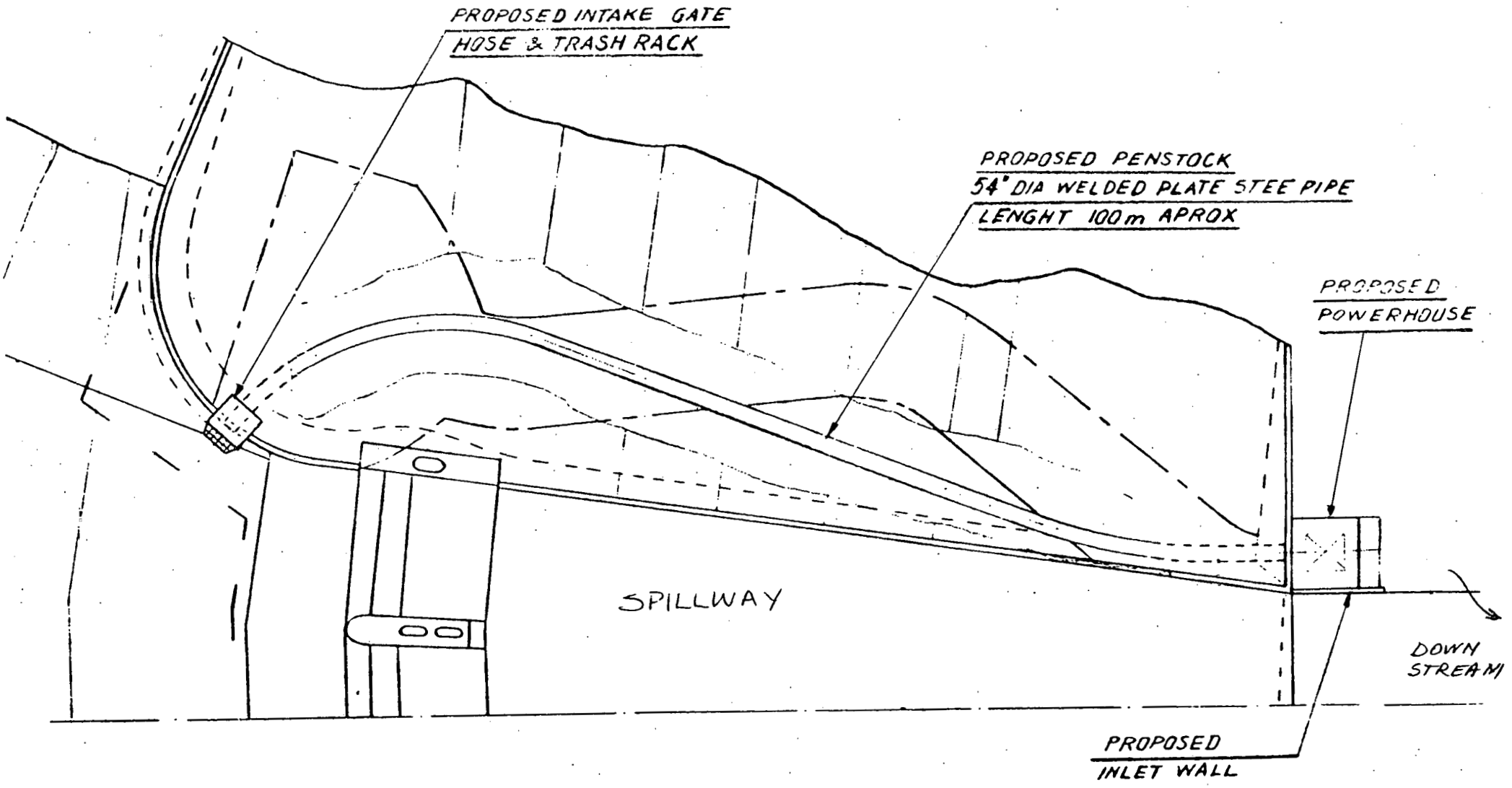


Figure 5.3. Existing spillway and location of proposed hydropower facility (Site 2). View from above.

The intake flow would contain no dissolved oxygen since it comes from more than 5 m (16.4 ft.) down (see dissolved oxygen data, Table 5.2), but the water would acquire substantial amounts as it drops from the turbine into the river bed.

There is the possibility of the entry of small amounts of oil into outflows from a poorly maintained turbine. The amount would be minute and not threatening to health, were the intermittent stream a source of drinking water. Because river flows have been sporadic since the construction of the dam, the area downstream from the spillway receives domestic water from the reservoir. The spillway turbine intake design includes a trash rack to exclude debris but should also include a finer mesh screen to keep fish from traveling through the turbine. The spillway turbine intake lies at a much shallower depth than intake at the earthdam, and numerous fish have been observed feeding in the area. The turbine discharge should be about the same temperature as water formerly washing over the spillway even though the source of the discharge is deeper in the reservoir. Table 5.3 contains reservoir temperature data and shows only slightly decreasing temperatures through the top 10 meters.

There already exists a 1/2 km dirt road connecting the spillway with the paved road running along the west side of the reservoir (see map, Figure 5.1) which will help minimize terrestrial disturbance during construction. The location of the turbine adjacent to the spillway (east side) will allow construction and later maintenance without interference with spillway operation, though during the dry season this should not be a serious concern. Dry season construction also reduces the likelihood of disturbing downstream waters since the riverbed is generally dry then. Some site pollution by human activities is expected during construction.

5.4.3 Site 3: Irrigation Canal

The third proposed location for turbine installation is about 2400 m (1.4 mi.) below the earthdam near an existing siphon. Power generation at this site requires enclosing irrigation canal flow within pressure pipe between the dam and the new powerhouse, and

TABLE 5.3. Temperature profile for Patillas Reservoir. Samples taken from four locations on two summer days.

DEPTH M (ft.)	SAMPLE SIZE	$\bar{X}$ TEMPERATURE ^{o}C (^{o}F)	STANDARD ERROR (for ^{o}C)
0 (0)	7	30.1 (86.2)	1.1
1 (3.28)	8	29.3 (84.7)	1.1
2 (6.56)	6	29.1 (84.3)	1.5
3 (9.84)	6	28.6 (83.5)	1.5
4 (13.12)	5	29.1 (84.4)	1.7
5 (16.40)	4	29.6 (85.3)	2.0
6 (19.68)	4	29.5 (85.1)	1.9
7 (22.96)	4	28.9 (84.0)	1.9
8 (26.24)	4	27.9 (82.2)	1.9
9 (29.52)	4	27.6 (81.7)	2.0
10 (32.80)	2	29.7 (85.5)	3.8

power output calculations assume prior outflow use for generation at site 1. The downstream turbine would run on flows released from the earthdam base for irrigation, municipal, and livestock needs and therefore would not effect new (or greater) variation in reservoir level. Because of the cost of pressure pipe, developing site 3 at this time appears less practical than restoring hydropower facilities at another reservoir.

The environmental effects of a small hydropower installation at this third site are straightforward. With reservoir levels determined by existing uses, no disruption of Biomphalaria or fish populations is anticipated, and downstream delivery is guaranteed. Turbine installation in the vicinity of the siphon will delay reoxygenation of water released from the dam, since there will be no contact with the air until it has passed through the turbine. This delay is not important unless there is an interest in fishing immediately below the canal hydropower site. Aeration at the turbine is a consideration if it is important to reoxygenate waters very quickly, but the resulting increase in probability of corrosion is a counter consideration. Fish injury is highly unlikely because there is no access to the canal above the turbine (inflows are piped between the dam and the power house). Some types of turbines can introduce minute amounts of lubricating oil to the canal if not properly maintained, but the amounts are not hazardous.

The siphon site can be reached by existing all-weather roads (see map, Figure 5.1) which should minimize but not eliminate disturbance to the site during construction. A by-pass for delivery during turbine installation and future maintenance will have to be constructed.

5.5 Aesthetic Considerations

In addition to maintaining ecosystem structure/function and local land use, preserving the aesthetic value of the hydropower setting is desirable. Again, dam construction (and pre-dam land use) has significantly altered the site from its pristine state, but

the reservoir is now considered a scenic attraction. All three of the proposed facilities represent only subtle additions to existing structures and should provide little visual distraction. Planned enclosure of currently exposed irrigation works might be perceived as aesthetic enhancement while enclosure of open canal (site 3) might not. Any noise made by generators would be difficult to hear above the turbulent flow of the canal. Multiple site implementation of small hydropower could displace a significant amount of steam plant generation and resulting offensive air pollution.

Sections 5.6 and 5.7 of this chapter are tables summarizing the effects of hydropower development at Patillas Reservoir. Section 5.6 considers site 1, the present best option, in detail, while section 5.7 reviews the environmental concerns at all three sites more generally. The University of Puerto Rico Center for Energy and Environment Research environmental assessment appears as the next chapter (following summarizing tables and references). The in-house ER&A evaluation was prepared in conjunction with the proposed engineering plans, while the CEER document was prepared within the comprehensive Puerto Rican perception of local needs and concerns.

5.6 TABLE OF ENVIRONMENTAL EFFECTS OF SMALL HYDROPOWER DEVELOPMENT AT THE IRRIGATION OUTFLOW (SITE 1)

Environmental Effect	Significance	Probable Cause	Likelihood after Hydropower Development	Justification
I. Increase in risk of bilharzia transmission	Major health concern	Disturbance of *Marisa* populations in reservoir through more drastic lake level fluctuations; cessation of existing control program.	Very low	No new fluctuations; control program to be maintained
II. Reduction of oxygen content of down-stream waters	Makes water less suitable for aquatic organisms	Release of greater quantities of deoxygenated water from lake bottom to irrigation canal	Zero	Turbine uses existing irrigation/ municipal/livestock allocation
III. Detraction from lake's recreational value	Displaces pleasure boaters and fishermen	Release of greater quantities of reservoir water than at present	Zero	Turbine uses existing irrigation/ municipal/livestock allocation
IV. Disruption of interactions among reservoir fish species	Unfavorable change in fish composition	Increased drawdown	Zero	No increased draw-down; fish community in disequilibrium and not really disruptable
V. Loss of irrigation water during power generation	Stress to crops	Diversion of irrigation water	Zero	No diversion included in proposed design
VI. Loss of irrigation water during construction	Stress to crops	Closing outflow	Zero	Design allows existing system to work until new pipe can deliver water to canal

5.6 TABLE (continued)

Environmental Effect	Significance	Probable Cause	Likelihood after Hydropower Development	Justification
VII. Erosion and downstream siltation during construction	Clog irrigation canal; negative effect on municipal water supply	Vegetation removal for road building and site clearance	Medium	No roads to be built but some disturbance to the site unavoidable
VIII. Increase in risk of flooding riverbed	Interfere with land use	Diversion of irrigation water to spillway	Zero	No diversion included in proposed design
IX. Changes in estuary salinity	Disrupt aquatic life	Diversion of irrigation water to spillway	Zero	No diversion included in proposed design
X. Changes in downstream water temperature	Disrupt aquatic life	Release of reservoir water from different depth with different temperature	Zero	Existing irrigation intake used for power generation
XI. Injury to fish passing through turbines	Decrease fish populations in reservoir	Fish caught in intake	Very low	Trash rack blocks entrance to turbine; fish not likely to forage in oxygen-poor depths
XII. Interference with migratory fish	Interrupt breeding cycle; decrease fish populations	Turbine blocks fish passage through dam (already almost impossible)	Zero	No migratory fish
XIII. Changes in lake benthic ecology	Disrupt community providing food for fish	New bottom disturbances	Zero	Turbine intakes are existing irrigation intakes and operate passively

5.6 TABLE (continued)

Environmental Effect	Significance	Probable Cause	Likelihood after Hydropower Development	Justification
XIV. Changes in canal benthic ecology	Disrupt community providing food for fish	New bottom disturbances	Zero	No change in discharge schedule to canal from existing irrigation plan
XV. Changes in river benthic ecology	Disrupt community providing food for fish	New bottom disturbances	Zero	No new discharge to river
XVI. Increases in mosquito population in estuary	Health problem	Increased standing water in estuary	Zero	No new discharge to river (and ultimately the estuary)

5.7 TABLE OF ENVIRONMENTAL EFFECTS OF SMALL HYDROPOWER DEVELOPMENT AT PATILLAS RESERVOIR

Environmental Effect	Site #1 Irrigation Outflow	Site 2 Adjacent to Spillway	Site 3 In Irrigation Canal
I. Increase in bilharzia risk.	None foreseen	None foreseen	None foreseen
	An increase in the risk of bilharzia would be likely given more drastic lake level fluctuations and cessation of current control programs. None of the proposed hydropower facilities would require reservoir drawdown different from that at present which might threaten populations of snails which control the bilharzia intermediate host. Continued monitoring and control measures should maintain the absence of Biomphalaria glabrata from Patillas Reservoir.		
II. Reduction of oxygen content of downstream waters.	None	Slight	Slight
	The irrigation outflow turbine would use existing flows (which are deoxygenated due to the reservoir depth they come from) without changing their character. The spillway turbine would draw deeper water than that which normally spills, but the drop from the turbine to the riverbed should almost completely oxygenate the outflow. Enclosing flow between the dam and irrigation canal powerhouse will delay the natural reoxygenation of canal water for 2.5 km (1.4 mi.); the canal is 42 km (26.1 mi.) long. The dissolved oxygen changes are viewed as unimportant since there is little downstream fishing. Lack of oxygen in the water would protect turbines from corrosion.		
III. Detraction from lake's recreational value.	None	None	None
	None of the development options includes new drawdown on the reservoir which might affect boating, fishing, or scenic value. Construction should only minimally disturb each site, thus surrounding beauty will be maintained.		

Environmental Effect	Site 1 Irrigation Outflow	Site 2 Adjacent to Spillway	Site 3 In Irrigation Canal
IV. Disruption of fish species interactions	None	None	None
	None of the options include new drawdown which might alter the fish community status quo. Little local interest in fishing and the imperturbable nature of the existing fish community minimize this concern.		
V. Loss of irrigation water during power generation	None	None	None
	The irrigation outflow and canal turbines would use existing outflows without interference. The spillway turbine would generate power from the amount of water which annually discharges over the spillway.		
VI. Loss of irrigation water during construction and future maintenance	None	None	Slight
	Both the existing irrigation system and spillway can operate independently of the hydropower installations and can be used to deliver water during construction and maintenance. At the irrigation canal site a bypass will need to be constructed which could conceivably require flow cutoff for a short time while it is connected with the canal.		
VII. Erosion and downstream siltation during construction.	Slight	Slight	Slight
	No roads need to be built into any of the hydropower sites, but some terrestrial disturbance is unavoidable.		
VIII. Increase risk of flooding riverbed	None	None	None
	No design option calls for increasing spillway discharge		
IX. Changes in estuary salinity	None	None	None
	No design option calls for increased delivery to the Marin River which joins the (former) Rio Grande de Patillas and flows about 7 km (4.3 mi.) to the sea south of the spillway. (Increased flows would probably enhance the estuary as aquatic habitat by restoring more natural salinity.)		

Environmental Effect	Site 1 Irrigation Outflow	Site 2 Adjacent to Spillway	Site 3 In Irrigation Canal
X. Changes in downstream water temperatures	None	Slight Possible	None
	Both the irrigation outflow and canal turbines are designed to use existing dam releases. The spillway turbine would draw water from 9 m (29.5 ft.) below the surface. July temperature profiles for the reservoir show little decrease in water temperature from the surface through the intake depth. At other times of the year temperature could vary more with depth, and turbine release might be a different temperature from what normally spills.		
XI. Injury to fish passing through turbines	Slight Possible	Slight Possible	None
	At site 2 a small mesh screen should be installed to block the passage of fish through the turbine. At site 1 the intake lies well beneath the oxygenated surface layer of the reservoir where fish forage. The turbine at the irrigation canal siphon would be inaccessible to fish.		
XII. Interference with migratory fish	None	None	None
	No migratory fish (which need to pass through turbine sites to reach spawning grounds) live downstream from the proposed turbine sites.		
XIII. Changes in benthic ecology of reservoir or downstream	None	None	Slight Possible
	The passive intakes of all three turbines should continue not disturbing the adjacent reservoir bottom. Downstream discharges with development will be of same magnitude and frequency as currently and should not affect benthic communities. The enclosure of flow in pressure pipe for the irrigation canal turbine will eliminate the existing benthic organisms in the first 1.2 km (3/4 mi.) of the 42 km (26.1 mi.) Patillas Canal.		

Environmental Effect	Site 1 Irrigation Outflow	Site 2 Adjacent to Spillway	Site 3 In Irrigation Canal
XIV. Increases in mosquito populations in estuary	None	None	None

No design options include changes in discharge to the Marin River below the spillway and ultimately the estuary of the Rio Grande de Patillas downstream.

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ENVIRONMENTAL IMPACT ASSESSMENT ON PROPOSED RETROFITTING OF LOW HEAD TURBINES FOR HYDROELECTRIC POWER GENERATOR IN EXISTING PATILLAS RESERVOIR, PUERTO RICO

ENVIRONMENTAL HEALTH AND IMPACT DIVISION
CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

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SUMMARY

This environmental impact analysis concerns the potential effect of a set of turbines proposed for installation in the outlet structures of the dam forming Lake Patillas in Puerto Rico. The lake was built for irrigation purposes in 1914, thus it discharges to an irrigation canal and also has an overflow to the Patillas River. The lake has a low biological productivity due to large fluctuations and poor vertical circulation. The proposed turbines will utilize existing discharges and outlet structures and it is thus estimated that there will be no noticeable environmental impact.

ENVIRONMENTAL IMPACT ASSESSMENT ON PROPOSED RETROFITTING OF LOW HEAD TURBINES FOR HYDROELECTRIC POWER GENERATOR IN EXISTING PATILLAS RESERVOIR, PUERTO RICO

INTRODUCTION

Renewed interest in hydroelectric power for Puerto Rico has resulted in re-examination of existing reservoirs for installaton of new turbines to decrease dependency on foreign oil for power generation. Lake Patillas in southern Puerto Rico was selected for a feasibility study and was therefore investigated for the potential environmental impact of such installations, in order to offset any possible adverse effects. This report summarizes the estimated environmental impact of the proposed turbine installations.

Site Description

Patillas Lake is formed by two earthen dams across the Patillas and Marin Rivers, near the town of Patillas, Puerto Rico. The dams were constructed in 1914 to supply irrigation water to the south coast for sugar cane cultivation. The ecology of the lake was investigated in 1978 and is described in the appendix to this report.

Proposed Modifications

The proposed turbogenerator set will be installed at the

existing irrigation canal outlet in the earth dam, and will utilize releases presently scheduled for irrigation, livestock and domestic uses. Thus no changes are proposed in the present discharges.

An additional option involves a turbogenerator installation at the concrete spillway, utilizing spillage which occurs normally. Again this would not change the present patterns of discharges from the lake.

Possible Adverse Environmental Effects

After careful review of the proposal design and the existing ecology of Lake Patillas and the downstream riverbed and irrigation canal, it is estimated that no noticeable environmental effect will be caused by the proposed turbogenerator installation. Neither the discharge patterns downstream nor the fluctuation patterns in the lake will be changed, since the turbines will utilize presently scheduled discharges.

The only possible effects of the proposed installations would occur during construction and these should be minimal since it is proposed that the work downstream of the dam will be isolated from the water in the lake by the existing gate valve on the irrigation intake, and by a coffer dam on the spillway.

After examining each of the potential environmental effects considered initially, it is concluded that the final designs proposed by Energy Research and Applications, Inc. (in their Interim Report of 3 November 1978 and in subsequent correspondence) should have no noticeable impact on the environment.

APPENDIX

A Description of Existing Environmental Conditions in Patillas Reservoir of Puerto Rico, October 1978.

A Description of Existing Environmental Conditions in Patillas Reservoir of Puerto Rico, October 1978.

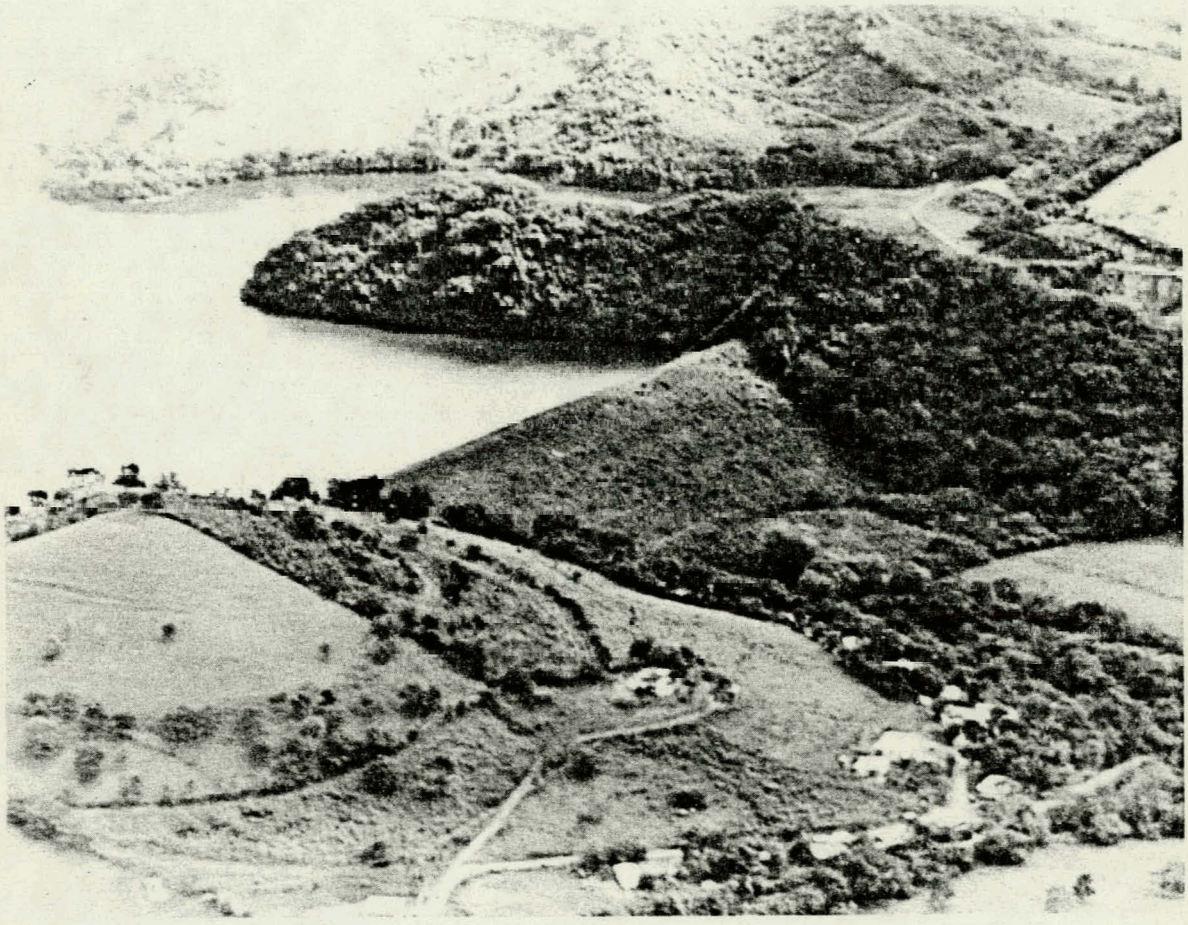
Summary

Patillas Reservoir was constructed in 1914 by building an earthen dam across the Patillas River, slightly northwest of the town of Patillas, Puerto Rico. The reservoir supplies irrigation water to sugarcane fields west of the reservoir and is also being considered as a source of hydroelectric energy. This report outlines the existing environmental conditions in the reservoir as part of a larger study to ascertain the cost and effectiveness of the proposed hydroelectric turbines.

At present only a portion of the storage capacity is used for irrigation thus the lake is often full and contains relatively clean water. It is an attractive lake in a rural setting and supports a variety of aquatic life including fish, mollusks, turtles and birds. Limited recreational fishing by local people occurs around the reservoir and a modest amount of pleasure boating occurs on weekends but the colored water and wooded shoreline are not conducive to swimming. . In the recent past the surrounding area was an endemic zone for the parasitic disease bilharzia, transmitted by aquatic snail. Thus swimming and water contact were activily discouraged by the health authorities until recently when the bilharzia problem was reduced to a reasonably low level.

The upper 5 meters of the lake waters are fairly well oxygenated by algae with mean concentrations of 7 to 8 mg/l of oxygen, sufficient for most fish in Puerto Rico. However the extreme fluctuations in water level due to a 10 meter drawdown during the irrigation season, severely limits the fish population, favoring only Tilapia mossambica. Below 5 meter depths the water is often anaerobic, probably due to respiration by decaying algae which fall from the upper, sunlit layer. This oxygen stratification is not caused by a temperature gradient, thus seasonal overturns do not occur to mix the lake.

Addition of hydroelectric generating facilities to the existing dam might affect the fish population by increasing the range of fluctuations and might affect the present balance of snail populations for the same reason. If the turbines discharge from the lower layer of deoxygenated water into the original river bed, this could also affect aquatic life downstream. Recreational use would also be affected by increased withdrawal for power generation.



Patillas Reservoir in Puerto Rico was initially constructed to supply irrigation water to the South Coast sugarcane fields, and is now being considered for installation of low-head turbines to generate hydroelectric power. (Photo by Guillermo Sosa, Puerto Rico Energy Office).

A Description of Existing Environmental Conditions in Patillas Reservoir of Puerto Rico, October 1978.

INTRODUCTION

This report is a preliminary description of environmental conditions in Patillas Reservoir as part of a feasibility study on the installation of low head turbines in the dam, for production of electrical power. The information reported herein was collected in 1978 on water quality, biota and general environmental conditions and from reconnaissance surveys made of the watershed, the lake, the Patillas irrigation canal and the riverbed, both upstream and downstream of the lake. In addition, information was obtained from previous surveys by the Human Ecology Division and from published reports cited in the bibliography.

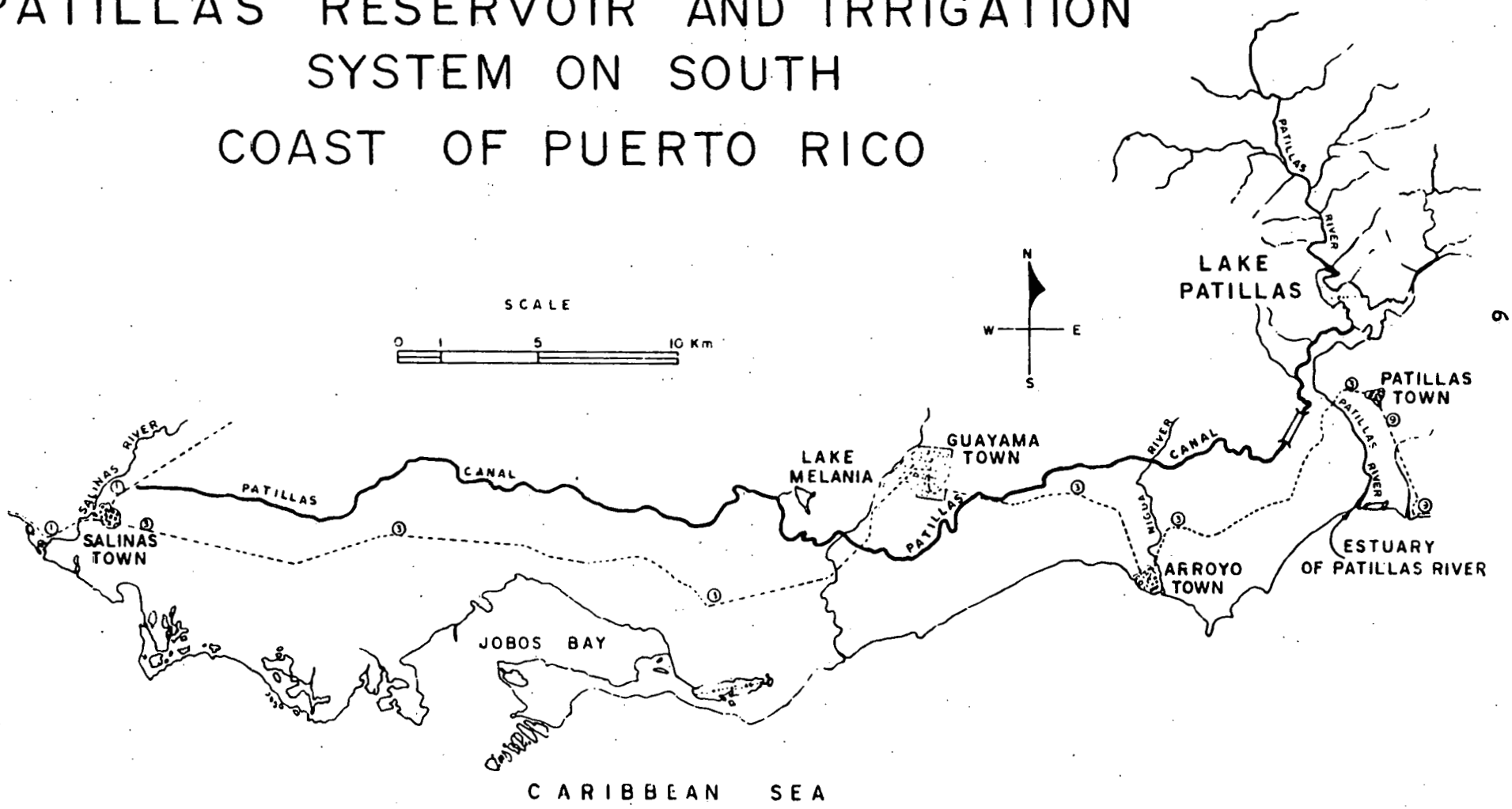
GENERAL DESCRIPTION

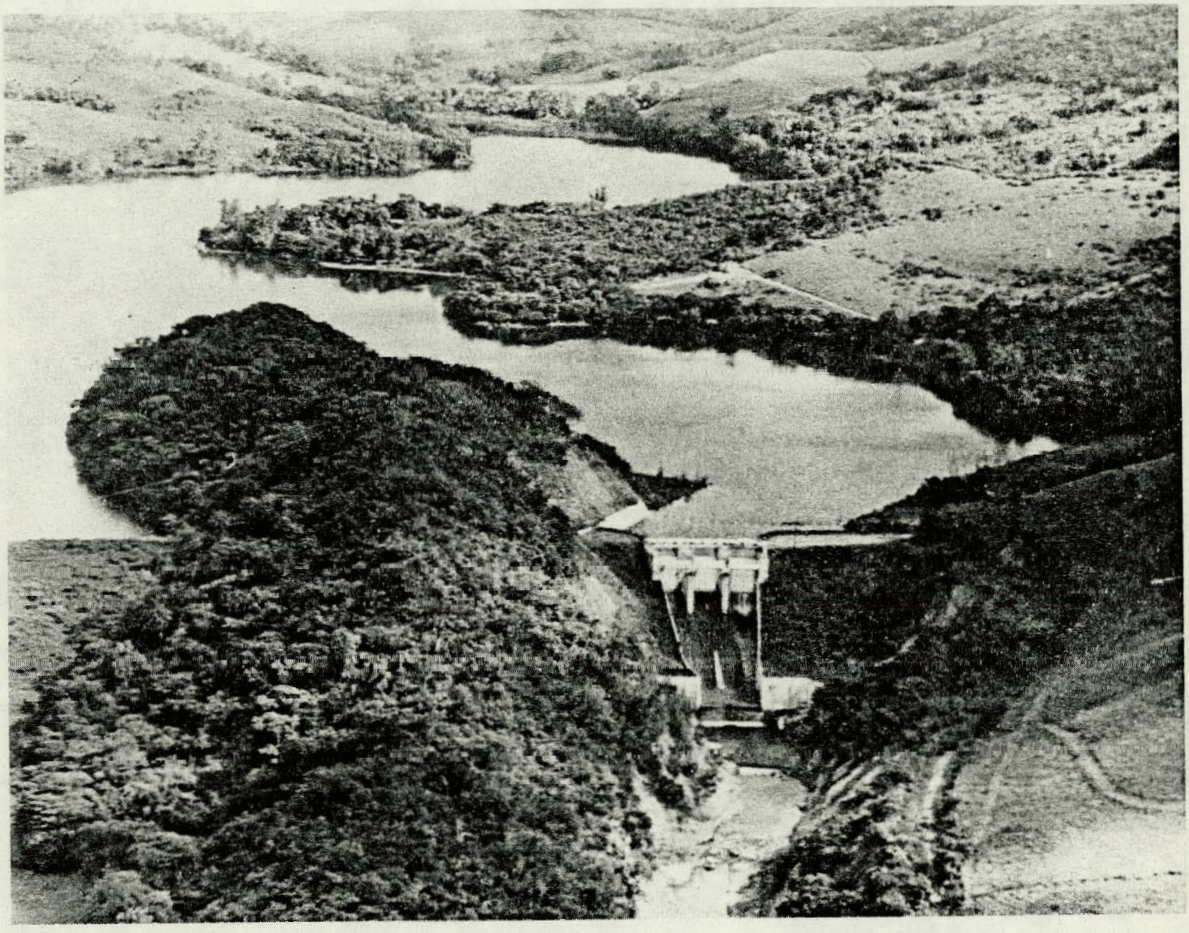
The Patillas Reservoir is the second oldest lake in Puerto Rico, constructed as part of the South Coast Irrigation System in 1914 to supply water for irrigation of sugar cane. The sugar from this and other irrigated areas is the principal agricultural export of Puerto Rico. In combination with canals from Carite Reservoir, the Patillas Canal supplies water to the entire coastal strip from Patillas to Salinas (Figure 1). The earthen dam consists of a main dike across the original bed of the Patillas River, and an additional dike which serves as the emergency spillway, across the former course of the Marin River. The dam provides a usable storage capacity of about 23 million cubic meters.

The watershed contributing to the reservoir is rural and sparsely populated, with steep hillsides and a total area of 65 square kilometers. Rainfall occurs primarily from August to December, and the drawdown period for irrigation extends from February to July. However in recent years two factors have caused an increase in the portion of the year in which the reservoir remains full. In 1976 a new spillway was constructed to reduce water loss from the previous, damaged structure (Figure 2). Secondly the acreage of irrigated cane has been reduced in Puerto Rico starting in 1960 and accelerating in 1975 with the closing of several mills. Thus during 1978 the reservoir remained full throughout the year.

FIGURE I

PATILLAS RESERVOIR AND IRRIGATION SYSTEM ON SOUTH COAST OF PUERTO RICO





The recently constructed spillway gates on the eastern end of the dam on Lake Patillas give better control of overflows. (Photo by Guillermo Sosa, Puerto Rico Energy Office).

Because of the rural nature of the watershed, the poor fishing characteristics of the lake, its remoteness from large cities, and local problems with the parasitic disease bilharzia, the lake has never become a recreational center for water contact activities, although it is a scenic attraction at maximum reservoir level.

Above the normal high-water line, Lake Patillas is bordered by a narrow band of young, dry coast forest, backed by grassy pastureland of guinea grass. In the normal fluctuation zone emergent grasses and reeds predominate, especially along the southwestern shore of the lake (Station 3 in Figure 3). There was no floating vegetation in the lake, although considerable wood and debris accumulates along the dam and southwestern shore, due to the prevailing northeasterly winds. Wave action on this shore is minor and no erosion was observed.

The canefields and canal systems downstream of the lake were the setting for a severe outbreak of bilharzia (schistosomiasis) a few years after construction of the South Coast System. By 1950 this focus of disease had become the major health problem in Puerto Rico and a control program was initiated in 1954, achieving virtual elimination of the disease on the South Coast by 1970. Patillas Reservoir was a major habitat of Biomphalaria glabrata, the intermediate snail host which transmits Schistosoma mansoni, the parasite causing the

disease in Puerto Rico. During control operations a major transmission site was found in the Barrio (borrough) of Mulas on the Patillas River slightly upstream of the reservoir. The community of Mulas continues to be a potential bilharzia problem since the river is used extensively for bathing and could cause a renewed outbreak if the snails return in Mulas Creek or in the Patillas River.

The bilharzia control program included chemical treatment of the snails in the river and biological control of the snails in the reservoir, a highly effective strategy which stopped transmission in a relatively short time. No transmission occurs at present in the South Coast System but snail control operations continue on a minimum level since the snail has not been eradicated. At present no drugs are available in Puerto Rico for treatment of the disease so only preventive measures are used.

The riverbed downstream of the reservoir contains a low continuous flow on a rocky and sand bed, until it reaches a small estuary closed by a sand bar. The lower riverbed is undeveloped but is a popular site for fishing and bathing by local residents, and pigs are raised along the riverbank as well. The vegetation along the riverbed is primarily wild sugar cane and guinea grass.

The dam is located at the geographical transition from the steep mountains to the flat coastal plain. Thus the soils above the reservoir lack clay horizons, and are classified as poorly developed Inceptisols of the Mucara y Naranjito Group. Immediately downstream of the reservoir is the alluviated plain and the beach, classified as highly fertile Entisols of the Alubion Group. The original bed of the river at the immediate site of the reservoir is sandy with large boulders.

There are no animals or plants in the vicently of Patillas Lake which are on the Federal List of Endangered Species or on the locally compiled list.

The Patillas Canal is 42 kilometers long, unlined for the most part, and was designed to deliver 3.6 cubic meters per second at a velocity of 0.6 meters per second. The canal requires considerable maintenance and vegetation removal.

WATER QUALITY

The quality of water in Patillas Lake in 1978 was generally good, with adequate concentrations of oxigen and low amounts of organic material and nutrients (Table 1 and Figure 3). Previous surveys in 1975 and 1976 confirmed the clean nature of the lake (Table 2). In the upstream portion of the watershed there are no discernible sources of pollution except for normal run-off from agricultural lands and roadways. Nutrient levels were low with only traces of phosphates in most samples, although nitrates were occasionally found in moderate amounts.

Despite the low levels of contaminants the lake water was not particularly clear, with Secchi disk readings of only 1.7 meter in depth. The surface layer contained considerable algae and color which reduced light penetration. Water temperature in the surface layer was fairly high, reaching 28°C in the summer months.

In comparison with the mean values for 11 other major reservoirs in Puerto Rico, Lake Patillas had markedly lower than average concentrations of hardness and iron, but was about average in all the others parameters measured (Table 3).

Table 1

Summary of Water Quality on Lake Patillas, 1978*

Chlorides	9.6 ± 3.1	mg/l
Hardness as $CaCO_3$	29 ± 17	mg/l
Total Phosphates as P	0.01 ± 0.01	mg/l
Nitrates and Nitrites as N	0.14 ± 0.19	mg/l
Iron as Fe	0.07 ± 0.10	mg/l
Turbidity	9.6 ± 6.3	Standard units
Color	10.6 ± 2.0	Standard units
pH	7.7 ± 0.3	
Dissolved Oxygen	7.4 ± 0.7	mg/l
Temperature	28.1	°C
Depth of Secchi Disk Reading	1.7	Meters

*See Appendix for data record.

LOCATION OF SAMPLING STATIONS FOR SURVEY OF LAKE PATILLAS

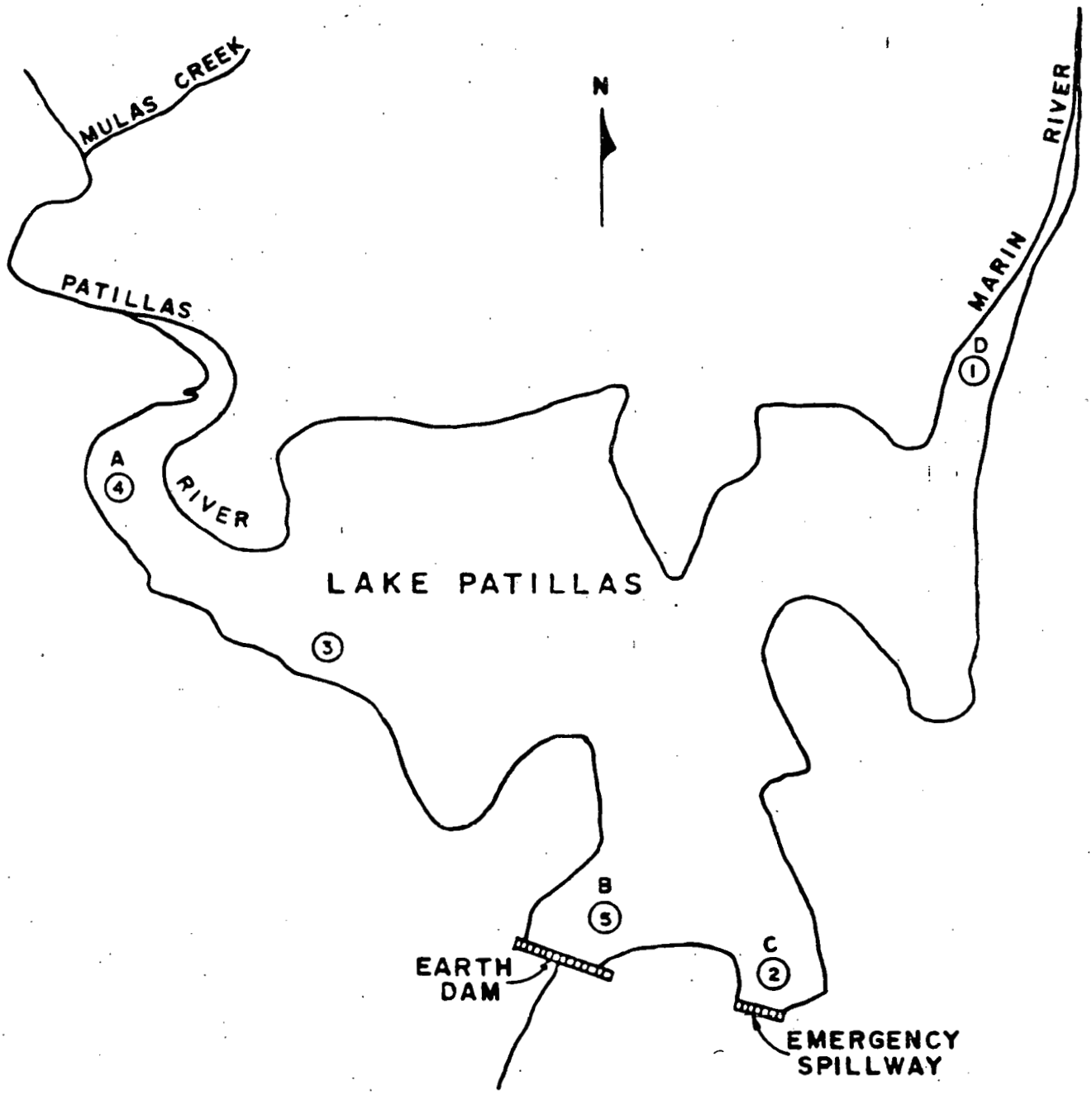


FIGURE 3

Table 2

Summary of Water Quality in Lake Patillas, 1975-1976*

Biochemical Oxygen Demand (BOD_s),	mg/l	2.2
CO_2	mg/l	0.4
PO_4	mg/l	< 0.001
pH		8.4
Alkalinity as $CaCO_3$,	mg/l	60
Specific Electric Conductance,	micromhos	130
Total phosphorus	mg/l	0.04
Nitrites	mg/l	0.02
Nitrates	mg/l	0.02
Chlorophyll	mg/l	0.011
Phaeo pigments	mg/l	0.001

*Summarized from DNR Report by Rivera González, 1976.

SUMMARY OF MEAN WATER QUALITY PARAMETERS FOR MAJOR LAKES IN PUERTO RICO, 1975-1978.

LAKE	CHLORIDES IN MG/L	HARDNESS AS $MgSO_4$ IN MG/L	TOTAL PHOSPHATES AS P IN MG/L	NITRATES AND NITRITES AS N IN MG/L	IRON IN MG/L	TURBIDITY IN STANDARD UNITS	COLOR IN STANDARD UNITS	PH	DISSOLVED OXYGEN IN MG/L	CHLOROPHYL A IN µG/L	COLIFORM BACTERIA GEOMETRIC MEAN PER 100 ML
Caonillas	5.9 ± 2.7	112 ± 21	0.01 ± 0.01	0.07 ± 0.06	0.15 ± 0.19	3.1 ± 3.7	13.0 ± 4.2	7.42 ± 0.50	7.1 ± 1.8	25.7 ± 15.7	1,919
Carite	7.7 ± 2.2	29 ± 16	0.01 ± 0.01	0.03 ± 0.03	0.16 ± 0.14	3.2 ± 0.6	9.8 ± 0.7	7.18 ± 0.16	7.0 ± 0.7		155
Carraizo	16.6 ± 4.1	126 ± 23	0.28 ± 0.33	0.33 ± 0.48	1.02 ± 1.11	18.3 ± 15.6	23.0 ± 10.1	7.24 ± 0.25	5.0 ± 2.1	12.9 ± 9.8	17,604
Cidra	14.2 ± 0.4	76 ± 0	0.02 ± 0.02	0.20 ± 0.11	0.56 ± 0.27	1.7 ± 1.5	8.2 ± 2.4	7.30 ± 0.23	5.4 ± 1.0		546
Dos Bocas	5.8 ± 1.6	97 ± 20	0.01 ± 0.01	0.15 ± 0.18	0.47 ± 0.59	8.4 ± 7.7	15.4 ± 14.0	7.38 ± 0.31	8.2 ± 1.9	2.6 ± 2.4	60
Garzas	3.2 ± 2.5	101 ± 93	0.02 ± 0.03	0.06 ± 0.04	0.08 ± 0.06	1.0 ± 1.1	8.5 ± 2.2	7.62 ± 0.29	6.7 ± 1.1		47
Guajataca	6.6 ± 5.8	224 ± 64	0.01 ± 0.00	0.47 ± 0.53	0.11 ± 0.09	7.6 ± 5.5	8.4 ± 3.4	7.36 ± 0.49	7.6 ± 0.3		102
Guayo	7.6 ± 4.7	110 ± 34	0.02 ± 0.03	0.28 ± 0.53	0.12 ± 0.23	2.7 ± 4.3	11.1 ± 1.8	7.63 ± 0.34	7.4 ± 0.9	7.1 ± 4.0	939
Matrullas	2.0 ± 1.4	21 ± 0	0.01 ± 0.00	0.53 ± 0.67	0.22 ± 0.04	1.8 ± 0.2	17.5 ± 10.6	7.85 ± 0.07	7.8 ± 1.0		64
Patillas	9.6 ± 3.1	29 ± 17	0.01 ± 0.01	0.14 ± 0.19	0.07 ± 0.10	9.6 ± 6.3	10.6 ± 2.0	7.72 ± 0.30	7.4 ± 0.7		399
Prieto	4.4 ± 3.2	157 ± 29	0.02 ± 0.02	0.29 ± 0.26	0.81 ± 1.30	25.3 ± 28.9	13.8 ± 5.9	7.44 ± 0.31	6.6 ± 2.5		2,704
Toro	5.0 ± 7.0	137 ± 2	0.01 ± 0.00	0.38 ± 0.09	1.30 ± 0.00	10.6 ± 0.0	10.0 ± 7.1	7.30 ± 0.71	6.8 ± 1.0		1,229
Means for all Lakes	7.4	101	0.04	0.25	0.42	7.8	12.6	7.5	6.9	12.0	448

Table 3A

Oxygen Data Summary for Major Lakes in Puerto Rico, 1975-1978.

Lakes	Initial Oxygen from Previous day mg/l	Light Bottle Oxygen mg/l	Dark Bottle Oxygen mg/l	Light -Dark Oxygen mg/l	Initial -Dark Oxygen mg/l	Water Temp. °C	Secchi Disk Depth M
Caonillas	7.1 ± 1.8	7.6 ± 1.3	5.6 ± 1.8	1.1 ± 1.5	1.9 ± 1.4	24 ± 1.9	1.0 ± 0.4
Carite	7.0 ± 0.7	7.2 ± 0.6	6.5 ± 0.6	0.7 ± 0.4	0.5 ± 0.3	23 ± 1.1	1.6 ± 0.2
Carraizo	5.0 ± 2.1	5.5 ± 3.7	3.4 ± 2.3	2.4 ± 3.0	2.0 ± 1.7	26 ± 1.6	0.5 ± 0.4
Cidra	5.4 ± 1.0	6.0 ± 1.1	5.0 ± 0.8	1.0 ± 0.5	0.6 ± 0.4	23 ± 1.0	-
Dos Bocas	8.2 ± 1.9	8.6 ± 2.1	7.1 ± 1.5	1.6 ± 1.5	1.5 ± 1.3	26 ± 1.6	0.9 ± 0.6
Garzas	6.7 ± 1.1	6.9 ± 1.1	6.3 ± 1.1	0.6 ± 0.3	0.4 ± 0.4	21 ± 2.5	2.1 ± 0.4
Guajataca	7.6 ± 0.3	7.9 ± 0.6	7.3 ± 0.2	0.6 ± 0.5	0.5 ± 0.1	26 ± 1.3	2.2 ± 0.2
Guayo	7.4 ± 0.9	7.9 ± 0.9	6.8 ± 1.0	1.1 ± 0.9	0.7 ± 0.4	23 ± 2.3	2.7 ± 1.6
Patillas	7.4 ± 0.7	7.6 ± 0.4	6.7 ± 0.3	0.9 ± 0.2	0.8 ± 0.6	29 ± 1.6	1.8 ± 0.5
Prieto	6.6 ± 2.5	6.3 ± 2.3	5.6 ± 2.1	0.7 ± 0.8	1.0 ± 0.7	22 ± 2.2	0.8 ± 1.5
Means for all lakes	6.9	7.2	6.0	1.1	1.0	24	1.5

Table 3B

DISSOLVED OXYGEN AND ALGAL PRODUCTIVITY

The oxygen level in the surface layer of the lake was generally stable and near saturation, adequate for warm water fish. The net daily production of oxygen by algae in the surface layer was low, about 0.23 mg/l; most of the oxygen produced during the day was utilized at night (Table 4). Gross production was only about 0.95 mg/l per day while respiration averaged 0.72 mg/l per day. As a consequence the oxygen concentration was fairly stable about the mean concentration of 7 to 8 mg/l, in the upper 5 meters of water. In contrast, the lower depths of the lake were generally deoxygenated due to respiration by algae and bacteria and by decaying matter on the bottom (Figure 4). This stratification was not caused by temperature gradients but rather by the consumption of oxygen in the deeper, dark zone, without compensating oxygen production from algae which occurred in the upper zone.

Lake Patillas had a vertical oxygen profile similar to Lake Dos Bocas, a larger and slightly contaminated lake downstream of Utuado on the Arecibo River (Figure 4). These two lakes had less oxygen than the clear but well fertilized Lake Guajataca, but more oxygen than the heavily contaminated Lake Carraizo. Thus Lake Patillas represents a typical artificial reservoir in Puerto Rico in respect to dissolved oxygen distribution and productivity.

Table 4

Summary of Oxygen and Algal Productivity

Data from Surface Waters of Lake Patillas, 1978*.

Temperature	°C	28.1
Depth of Secchi Disk Reading	m	1.7
Initial Oxygen	mg/l	7.45
Final Oxygen in Light Bottle after One Day	mg/l	7.68
Final Oxygen in Dark Bottle after One Day	mg/l	6.73
Gross Daily Respiration (Initial Oxygen minus Dark Bottle)	mg/l	0.72
Net Daily Oxygen Production (Light Bottle minus Inital Oxygen)	mg/l	0.23
Gross Daily Oxygen Production (Light-Dark Bottle)	mg/l	0.95

*Data is in Appendix.

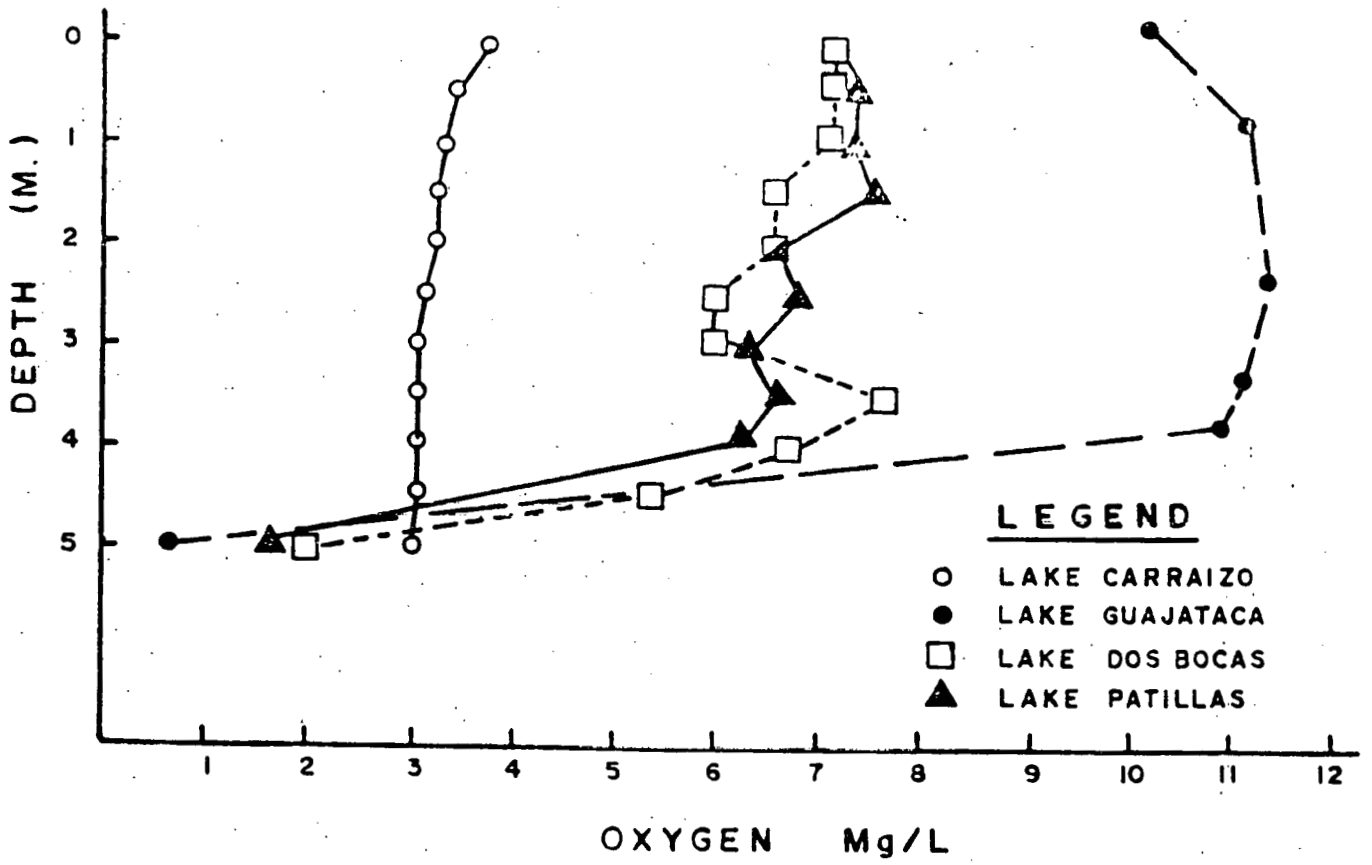

DEPTH (M.)
0
1
2
3
4
5
1
2
3
4
5
6
7
8
9
10
11
12
OXYGEN Mg/L
LEGEND
LAKE CARRAIZO
LAKE GUAJATACA
LAKE DOS BOCAS
LAKE PATILLAS

FIGURE 4

AQUATIC ANIMALS

Patillas Reservoir supports a normal population of algae and plankton, as well as small populations of snails, fish, turtles and birds. However the basically low algal productivity and the high degree of fluctuation in the water level limit the numbers of organisms and species.

The lake presently contains several mollusks, Marisa cornuarietis, Pomacea australis and Tarebia granifera. All of these snails are competitors with Biomphalaria glabrata, the bilharzia snail which was not found in the lake. However B. glabrata was present in Mulas Creek, a tributary of the Patillas River upstream of the lake, in Barrio Mulas. An unusually strong population of Pomacea australis was found in the entering rivers which were clear and gently flowing throughout 1978. This ampullarid snail proliferates under these conditions if the water level remains fairly stable, and if there are hard surfaces protruding above the waterline where it can lay its pinkish egg-masses. The adult snails were large and were probably increasing the competitive pressure already excerted by Marisa cornuarietis on any Biomphalaria glabrata which might be washed into the lake from Mulas Creek (Figure 3).

Table 5

List of fish in Lake Patillas, 1976*

Tilapia mossambica

Ictalurus nebulosus

Lepomes macrochirus

Cichla oceallaris

Gobiomorus dormitor

*Taken from Report by Department of Natural Resources, December 1976.

TRANSMISSION OF THE PARASITIC DISEASE BILHARZIA

The first bilharzia control project in Puerto Rico began in Patillas in 1954 when the prevalence of bilharzia in 6 year old children was 7% and in 7 year olds was 22%. The control effort was highly successful, reducing the prevalence to zero by 1965. The following year 2 infected children were found in Barrio Mulas but by 1976 there were virtually no infected people in the entire watershed. The program was based primarily on the use of chemicals in flowing water and the use of Marisa cornuarietis, a competitor and predator snail which was very effective against Biomphalaria glabrata in the lake and in slowly flowing waters. B. glabrata was last found in Patillas Lake about 1966.

Although the bilharzia danger is now quite low, the potential for a re-surgence around the lake exists, especially in Barrio Mulas just above the entrance of Patillas River. The snail B. glabrata is occasionally present, there is considerable human contact with the water, and although no gross fecal contamination was seen, promiscuous defecation by local residents and visitors is common. Thus an infected person from another area could infect the snails, causing danger of transmission at least on a local scale. As long as Marisa cornuarietis and the other competitors are in such large colonies in the lake however, there is little danger of significant transmission.

The Patilas canal is also free of B. glabrata and harbors massive colonies of Marisa cornuarietis and Tarebia granifera, thus transmission does not occur in the irrigated zone.

The prevalence of bilharzia in Puerto Rico is dropping, from 15% in 1963 to 4% in 1976. Thus it is hoped that the parasitic schistosome can eventually be eradicated from the island when a new drug is found. For the present however snail control must be maintained to prevent transmission.

Preliminary List of Potential Environmental Impacts from Hydroelectric Power Generation

The following list indicates the items which need to be considered in evaluating the possible environmental impact of the proposed hydroelectric turbines. A general evaluation is given of the likelihood of the effect, and of its significance.

Item	Likehood	General Significance
1. Change in Risk of Bilharzia transmission if Marisa population in lake is disturbed	small	moderate
2. Change in water quality downstream if deep de-oxygenated waters are discharged by turbines	large	moderate
3. Change in recreational value of lake if annual drawdown increases	moderate	small
4. Change in fish population in lake if annual drawdown increases	moderate	moderate
5. Continual loss of irrigation water if turbines discharge to riverbed	high	high
6. Temporary loss of irrigation water during construction	moderate	moderate
7. Erosion and downstream siltation during construction	moderate	small
8. Flooding of presently used land in riverbed due to increased discharge	small	small
9. Changes in Salinity in estuary due to increased river flow	high	small
10. Changes in water temperature in lake or downstream	small	small
11. Injury to fish passing turbines	small	small
12. Interference with migratory fish	not applicable	none
13. Changes in benthic ecology of lake	none	none
14. Changes in benthic ecology of downstream river	small	small
15. Changes in benthic ecology in canal	small	small
16. Changes in mosquito population in estuary	small	small
17. Displacement of human population	none	none

CONCLUSIONS

The Patillas reservoir is a clean lake with low productivity, limited by low nutrient concentrations. Fish populations are small due to widely ranging fluctuations, and the lake is not used extensively for recreation. The surface layers of the lake are warm and well oxygenated, supporting enough algae to reduce light penetration but not enough to cause much change in oxygen concentration. Below 5 meters in depth the lake is usually devoid of oxygen. Although there used to be a health hazard around the lake due to bilharzia transmission, the hazard has been significantly reduced by control of the aquatic snail involved.

Evaluation of the potential impact of installing hydroelectric turbines in the dam should concentrate on potential losses of irrigation water, changes in water quality and quantity in the Patillas River due to turbine discharges, and changes in fish and snail populations in the lake due to increased fluctuations in the water level.

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9. Puerto Rico List of Endangered Species.

6.0 LEGAL AND REGULATORY FEASIBILITY

6.1 Conclusion

The installation and utilization of the proposed new hydroelectric generator capacity at the Patillas site is feasible from a legal and regulatory point of view.

A. The hydroelectric development and utilization of the Patillas irrigation waters is specifically authorized by Puerto Rican Law, and may be undertaken by the Water Resourses Authority.

B. The technical information provided to this investigation shows that the hydroelectric generation will make use of normal irrigation canal flows (Phases I and III) or diversion of spill-off which would occur in flood season (Phase II). Accordingly, the normal water flows will not be disturbed and the water rights of down stream users will not be affected.

C. Federal Energy Regulatory Commission (FERC) licensing is not required for this project because neither the site, the watercourse, or the energy distribution network are of a character which would gain the necessary federal jurisdiction. However, even if federal jurisdiction (FERC) were present, the generators proposed in Phase I and III could be exempted from the request for licensing by virtue of the newly enacted Section 30 of the Federal Power Act (16 USC 832 {a}) which provides the commission (FERC) with the power to grant such exemption in the case of utilization of the hydroelectric potential of a man-made conduit operated for the distribution of water and not primarily for the generation of electricity. This exemption would not be available

6.1 Conclusion (cont'd)

for Phase II, and in this case, application could be made under the "short-form license" procedure issued by FERC on September 5, 1978.

D. Local Puerto Rican Licensing requirements are well understood by the Authority and would create no apparent impediment to the implementation and utilization of the project.

6.2 Review of Puerto Rican Law and Regulations

Puerto Rico has a well developed statutory scheme governing the Water Resources Authority which is set forth in Title 22 of the Laws of Puerto Rico. The basic modern enactment consists of the 1941 statute which establishes the Water Resources Authority. Prior thereto, a variety of special statutes relating to the several irrigation districts and electrification projects had been separately enacted, giving various agencies responsibility for pieces of the Commonwealth Water and Power System.

The 1941 Statute and its subsequent revision have created a coherent statutory scheme and established the Water Resources Authority as the central and paramount agency responsible for and authorized to deal with matters of electrical generation and irrigation. (See Appendix I for full list of pertinent statutes.)

The following sets forth a summary of important points related to this project:

1) The Authority is a public corporation, with an identity and powers and liabilities separated from the state. It is governed by a board of directors composed of seven members, five of whom are appointed by the Governor of

Puerto Rico with the consent of the Senate, and two of whom are elected by the electric power consumers. (22 Laws of Puerto Rico § 196, 197)

2) In forming the Authority the Legislature conveyed to the Authority all of the property constituting the "System of the Utilization of the Water Resources." (22 Laws of Puerto Rico § 198), and transferred to the authority all powers and duties related to the construction and operation of a public irrigation system and hydroelectric system of the South Coast Irrigation Service. (22 Laws of Puerto Rico § 214 and § 228)

3) The Authority is specifically charged with developing and operating hydroelectric resources and coordinating these with irrigation projects. It appears that the legislature gave due and substantial consideration to the hydroelectric resources placed in the hands of the Authority and contemplated their development and utilization. The legislature gave the Authority the specific power to arrange for the utilization and exploitation of potential water power developed in connection with the construction of the South Coast Irrigation System wherein the Patillas reservoir and the outflow aquaducts lie (22 Laws of Puerto Rico § 258); and as a part of the Legislature's "Statement of Motives" in conveying the South Coast Hydroelectric System to the Authority, the legislature said in part that such conveyance was intended to "...provide the means, not otherwise available, for expanding and improving properties now making up the hydroelectric system and thus meeting the ever increasing demand for electric power service in the district" (22 Laws of Puerto Rico § 228.(b)). It would thus appear that a clear and unequivocal state-

ment of legislative intent was made at the time the Authority was formed, mandating the development and exploitation of the hydropower.

4) The Authority is, by statute, specifically required to make water available for various purposes, including irrigation, municipal use, and live stock. These obligations are set forth directly in the statutes and/or contracts to which the Authority or its predecessors are a party, and as a result of water rights concessions attached to certain lands during the period of Spanish Rule. The utilization of irrigation waters for hydroelectric purposes shall not affect the right of the irrigated lands to receive irrigation waters (22 Laws of Puerto Rico § 229). However, it appears that the Patillas Hydroelectric Project will in no way effect the irrigation flow.

5) The Authority may fix and determine the rates it will charge for electric power. This absolute authority appears limited only by the limitation that the rates be sufficient to cover the expenses and obligations of the Authority (including those obligations undertaken by way of trust agreements related to the Sale of the Authority's bonds), and the authority of the Board of Directors to alter, suspend or revoke charges.

6) The current rate structure (although presently in the process of revision) is the same rate structure in force in 1964. This rate structure utilized a basic rate for each class of service and added or subtracted therefrom a fuel adjustment if oil cost fell below $1.60 per barrel or rose above $2.00 per barrel.

6.2 Review of Puerto Rican Law and Regulations (cont'd)

7) The Authority has substantial power to acquire all manner of property necessary to the conduct of its affairs, and may take property by condemnation. In addition, the Authority has full power to contract. (22 Laws of Puerto Rico § 203, 205, 255)

6.3 Federal License Considerations

It appears that the proposed hydroelectric installation is not within the jurisdiction of the Federal Energy Regulatory Commission. It will not occupy federal land, nor a federal dam, it will not utilize a navigable stream, nor will the electric energy generated be interconnected into an interstate network (See generally 16 USC § 791 et seq.).

Even if Power Licenses were required, this project would qualify for FERC's short form license application method. (See Appendix 2.)

Further, Phase I and III of the project could qualify for the special exemption provided for in the newly enacted 16 USC 823a. (Appendix 3 provides copies of two recent applications to the Commission for such exemption.)

6.4 Local Puerto Rican Licensing Requirements

A project of the kind contemplated by this study will require approvals from the following agencies:

1) The Planning Board

2) The Environmental Quality Board

3) The Regulation and Permit Administration (ARPE)

6.4 Local Puerto Rican Licensing Requirements (cont'd)

Application must be made to the Planning Board for a "Consulta de Ubicación" (i.e. a permit of Localization). The application to the Planning Board is made pursuant to Regulation #2 (See Appendix 4) (The current regulation was enacted in 1959, and there is presently being circulated for public comment, a new revision thereof (See Appendix 5).) A part of the input necessary to receiving the Planning Board's permission to proceed is a positive recommendation from the Environmental Quality Board. Based upon information received from personal interviews, it appears that the Environmental Impact Statement prepared by the Center for Energy and Environmental Research of the University of Puerto Rico (CEER) will serve as a sufficient input to the Environmental Quality Board. (The Planning Board has a form for the purpose of supplying environmental data. See Appendix 6.)

In addition to the recommendation of the Environmental Quality Board, the Planning Board may solicit the inputs or recommendations of other interested and potentially interested agencies (e.g. the Office of Energy, the South Coast Irrigation District, the Department of Natural Resources.)

Permits for the construction and use of each of the generator plants will be required. These permits are issued by ARPE and will encompass the usual requirements that construction and use be pursuant to the Building and Safety Codes. (ARPE has provided the forms for application for such permits. See Appendix 7.)

The process of applying for the necessary permits is carried out by the Authority as a part of the ordinary course of its business; and the appropriate agents of the Authority have the complete and necessary experience and understanding of the requirements to fully comply.

7.0 Equipment Availability and Evaluation

This section lists the manufacturers and vendors who responded with the hydraulic and generating equipment which best fulfills the requirements of the Patillas site.

The list of potential sources identified in the Interim Report has been narrowed down to the following suppliers. They were qualified on the basis of manufacturing and/or providing hardware responsive to design specifications and their interest in providing equipment and cost descriptions for the Patillas site hydropower retrofit feasibility determination.

7.1 Vendors, Equipment and Costs

7.1.1 The James Leffel & Company
Springfield, Ohio 45501
Tele: 513-323-6431
J. Robert Groff, President

I. Fixed Blade Vertical Installation Propeller Turbine $115,000.00
- a) install cylindrical case
- b) weight 40,000 lbs.
- c) cubical content 3,000 cubic feet
- d) F.A.S. New York
- e) 720 RPM - operating speed
- f) 2000 RPM runaway speed
- g) force required to operate wicket gate = 7200 ft. lbs.
- h) thrust = 32,000 lbs.
- i) WR^2 = 14,620

IA. Governor for above unit (Woodward) 19,500.00
- a) FOB Factory
- b) weight 2500 lbs.
- c) cubical space displacements = 250 cubic ft.

TOTAL COST LEFFEL UNIT I with IA $134,500.00

7.1 Vendors, Equipment and Costs(cont'd)

7.1.1 The James Leffel & Company

II. Adjustable Blade Vertical Installation Propeller Turbine a) same setting as Fixed Blade b) 72,000 lbs. weight c) cubical space displacement = 4200 cu. ft. d) FAS New York	$ 205,000.
IIA. Woodward Governor	38,000.
TOTAL COST LEFFEL UNIT II with IIA	$ 243,000.

Delivery time as of December 28, 1978 and based upon their production schedule, at that time, is 4 to 6 months.

7.1.1.1 Generators to go with Leffel Units

Ideal Electric
330 East First Street
Mansfield, Ohio 44903

Mr. Kohler
Tele: 213-564-7372

III. 700-750KW (std. unit) = 54,360.00 (3,000 WR^2)

IIIA. 850-900KW (std. unit) 9/7 X $54,360.00

IIIB. Larger Design Generator (14,620 WR^2) $ 91,200.00

IIIC. Generator w/Separate Flywheel would split cost difference between $54,360 and $91,200. 73,000.00

a) Each of above units includes generator, excitor & regulator.

b) Delivery 26 weeks after drawing approval. Allow up to 8 weeks for drawing preparation.

c) Freight paid to first point of consignment in continental USA.

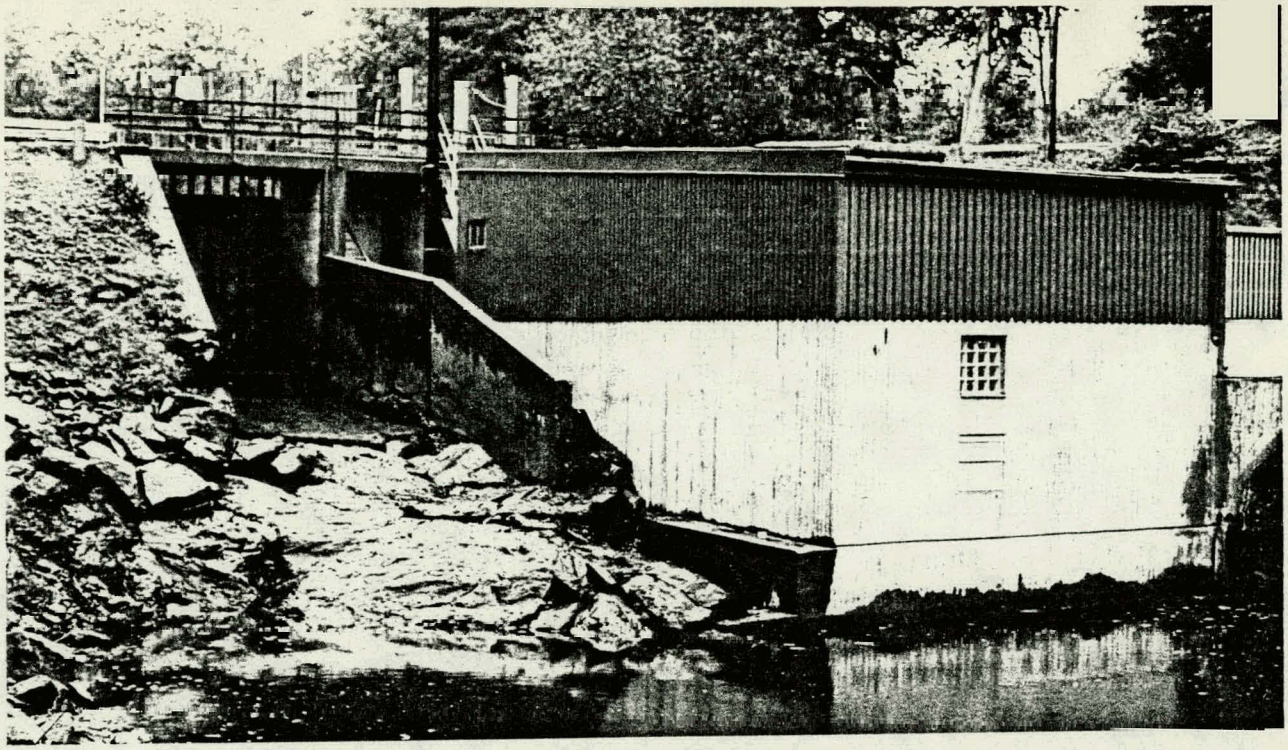
IV. Electric Machinery Manufacturing Co.
800 Central Avenue
Minneapolis, Minnesota 55413

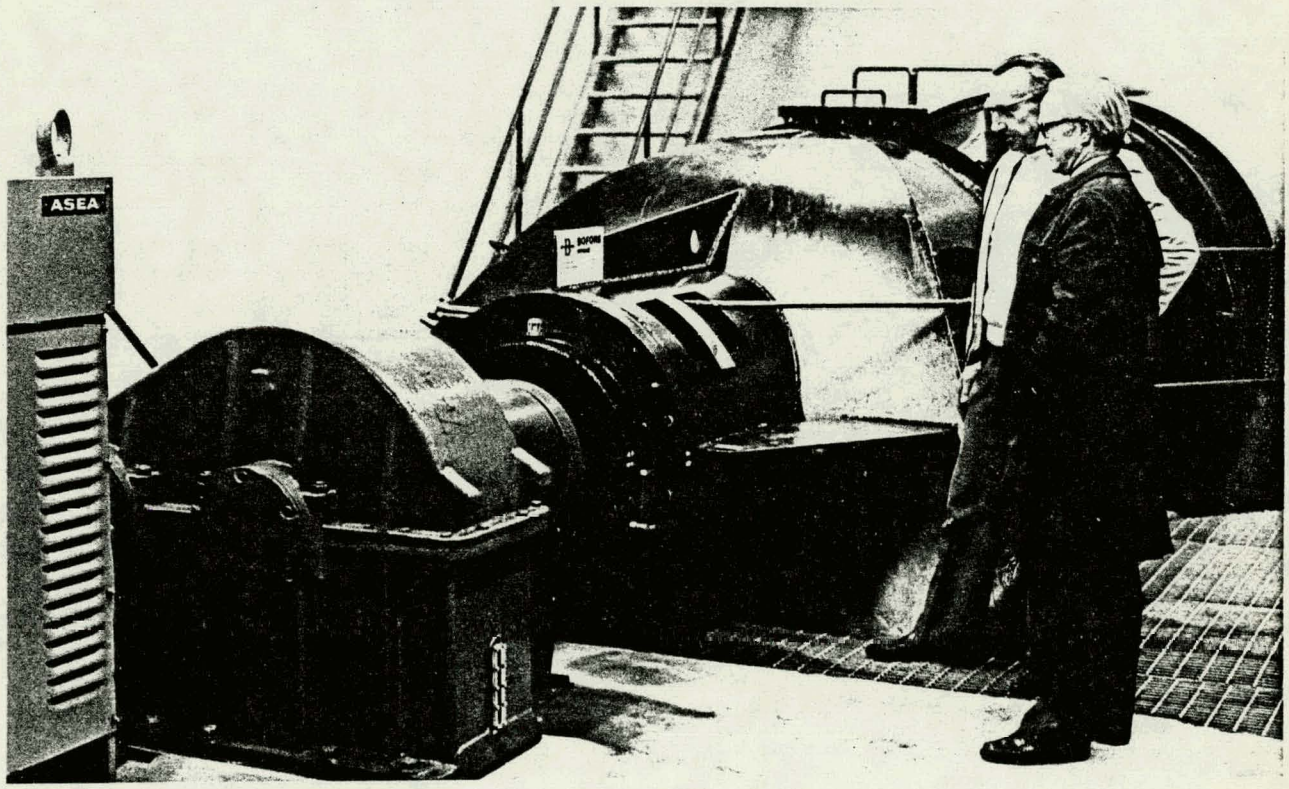
Mr. Echman - 213-921-8411

EMF Generator $ 73,002.00
a) 900 KW maximum capacity generator with excitor
b) Diameter 62"
c) Height - 130"
d) 105° temp. raise
e) Delivery - 26 - 36 weeks

CONCLUSION:

The minimum cost combining a Leffel Fixed Blade Unit with governor and 750KW capacity generator package is: 134,500.00
54,360.00
$188,860.00





This 502KW small hydropower installation in Kalseter, Sweden, is representative of current automated hydropower technology. The lower photo shows a horizontal turbine with gearbox and generator in place at the unattended site.

7.1.1.1 Generators to go with Leffel Units

Electric Machinery Manufacturing Co.

CONCLUSION: (cont'd)

The maximum cost combining a Leffel Adjustable Blade Unit with governor, and 750KW capacity generator package is:

	$243,000.00
	54,360.00
	$297,360.00

7.1.2 Allis-Chalmers
Hydro Turbine Division
P.O. Box 712
York, Pa. 17405

Howard Mayo 717-792-3511 ext. 675

V. 400KW Design Point Fixed Blade-Standard unit Tube turbine, horizontal installation — $225,000.00

VI. 900KW capacity - Custom Unit-Adjustable Blade, tube turbine, horizontal installation — $300,000.00

above units V and VI include the following components:

a) inlet valve
b) hydraulic turbine
c) gear unit
d) generator
e) governor/controller
f) electrical controls
g) transformer

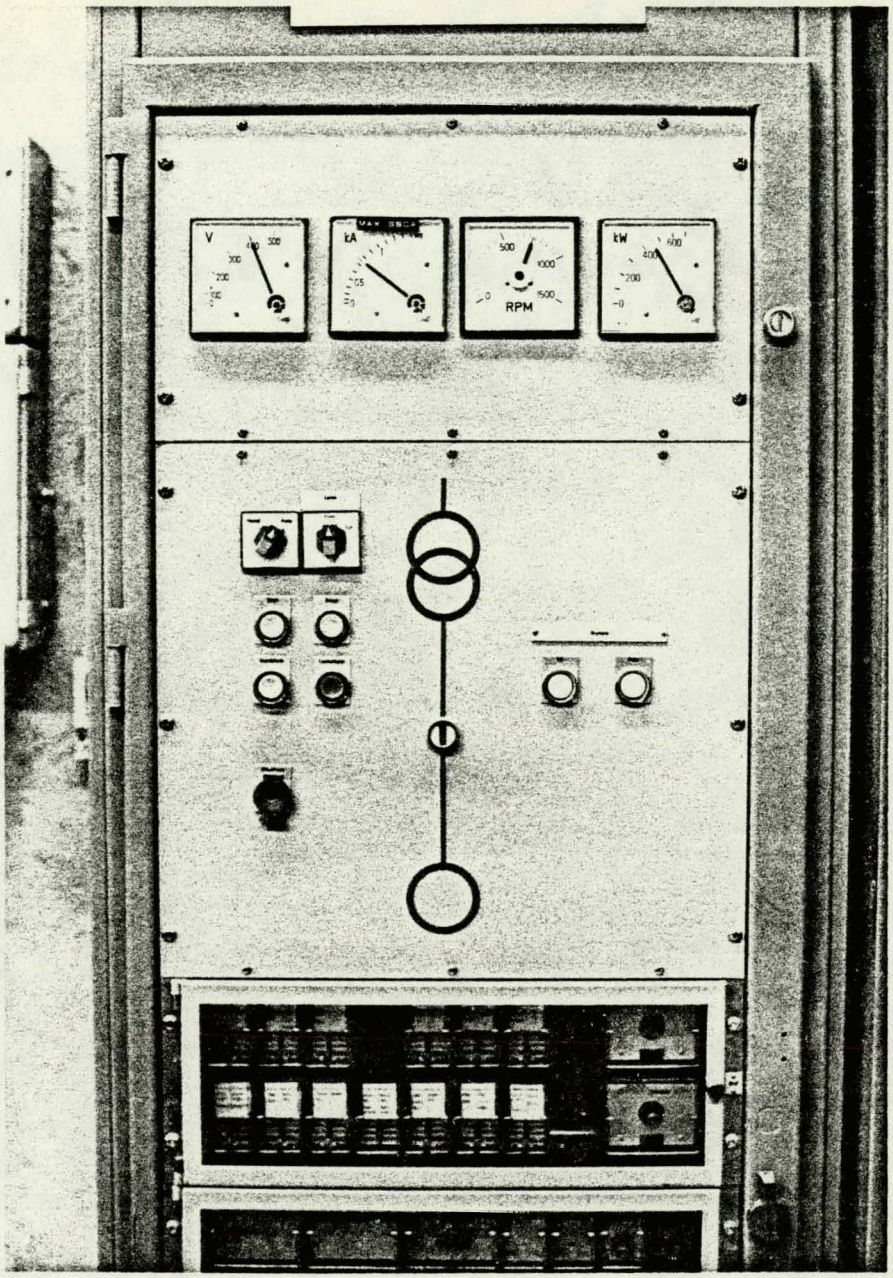
ALLIS CHALMERS UNITS RANGE IN PRICE FROM $225,000 to $300,000.

7.1.3 Bofors Nohab
New York, N.Y.

Arthur Meland - 212-466-0157

VII. Operating Parameters: 105cfs/27m maximum	70cfs/17m
vertical installation, standard unit	
Runner Ø = 700mm	700mm
5-bladed runner	4-blade
R_t = 918 RPM	same
using induction generator	
Runner $\mathbb{C}_L$ = 8.2 ft. below tailwater(2.5m)	$\mathbb{C}_L$ = + 1.6ft(0.5m) above tailwater
R_G = 900RPM (synch'd to grid)	
E_{oa} = .862	E_{oa} = .857
(from generator output terminals)	
Output @ 105cfs/27_m = 680KW	@ 70cfs/17m - 310KW
Butterfly valve Ø = 1000mm	same
Includes turbine,draft tube, intake tube, control valve, transformer, generator, capacitor, breakers, & automatic controls.	same
FOB Goteborg, Sweden - SK1,030,000	SK 990,000
4.35 SK/$1 $236,781.60	$ 227,586.20
7½% customs + 10% freight	
12 months delivery	

BOFORS UNITS COST RANGE FROM $227,586.20 to $236,781.60



Automatic controls for the hydropower installation at Kalseter. This installation reportedly averages 3-4 O&M hours per month to allow cleaning of chemical wastes from intake screens. No oversight or maintenance of the turbine or its controls is required.

7.1.4 Stapenhorst Co. (Montreal, Canada)

Mr. Kanger - 514-695-8910

VIII. Nominal head = 23 meters

Maximum Q = 105cfs; minimum Q = 70cfs

Generator Output = 515KW $221,000.00

FOB - Montreal, Canada

+ 7½% customs & 10% freight

including all equipment:
turbine with foundation
frame and connections(bolts, etc.)
draft tube
inlet section
flex. coupling
lubrication box and metering
generator
governor complete
generator panel including controls

TOTAL DELIVERED COST OF COMPLETE SITE EQUIPMENT PACKAGE: $259,675.00

7.2 Vendor Evaluation and Cost Parameters

The foregoing vendors are the only ones who responded with bids for the feasibility study.

Others contacted such as Fuji, Hitachi, Escher Wyss, Gilbert, Gikes & Gordon, etc. stated the job was too small or that they would be interested in bidding when potential was determined and site approved.

Equipment costs to meet determined Patillas retrofit requirements vary from a low of $188,860.00 to a high of $334,200.00 and are subject to review for fixed price. Delivery time ranges from a minimum of four(4) months to a maximum of 12 months.

All of the responding vendors are well established and reputable firms, with competent staff to work out final details once the decision to implement is reached.

It is ER&A's recommendation once the decision is made to move ahead, that we act on hardware orders to bring the project to fruition in the shortest time possible. Among other benefits, equipment cost escalation and inflation factors can be thereby avoided or ameliorated.

8.0 Institutional and Social Feasibility Determination

8.1 Introduction and Summary

With the intent of identifying and investigating institutional, social or political barriers to the implementation of the Patillas Hydropower Development Project (if in other respects found feasible), extensive investigation was undertaken of the social and institutional climate of Puerto Rico; particularly those institutions and agencies which could be expected to be directly involved in or affected by such a project.

To this end, meetings were held with and inquiries directed to the active spectrum of relevant agencies and authorities, including: the Water Resources Authority, the Puerto Rico Energy Office, the Department of Natural Resources, the Corps of Engineers, the Aqueduct and Sewer Authority, the Bureau of Permits, the Planning Board, the Center for Energy and Environment Research, the Environmental Quality Board, the South Coast Irrigation District, the Bureau of Reclamation and the Federal Energy Regulatory Commission. Especially lengthy discussions were held with representatives of the WRA and PREO. Out of these discussions and investigations developed a picture of conditions and requirements as they currently exist in Puerto Rico, and of the needs and requirements for new energy-producing projects.

To summarize:

1) The study team found no preventative institutional barrier to the implementation of a small hydropower installation at Patillas, Puerto Rico.
2) The study team identified positive social effects to be derived from such a project.
3) The study team found such a project devoid of negative political impact, but to be consistent with the expressed goals of the Government of Puerto Rico.

These findings will be expanded in some detail in the section to follow.

8.2 INSTITUTIONAL CLIMATE

Study of the feasibility of new or unfamiliar systems and technologies must take into account the institutional climate within which the proposed project is to be accomplished. Just as technical projects have environmental and economic repercussions which may or may not reflect favorably upon the feasibility of a project as a whole, so can they have effects upon the institutions of the area for which a project is proposed. Similarly, such projects may sometimes encounter institutional barriers to their completion, which may not be easily discernible during the planning stage if careful study of local issues and effects is not made and the results thoroughly analyzed.

The primary concern of the study team in this area of institutional concerns was to determine which agencies and institutions of Puerto Rico would be directly or indirectly concerned by a project such as that proposed at Patillas. Several agencies and jurisdictions were identified, and these, along with their concerns and requirements, have been discussed in the regulatory section of this report, when germane. The agencies which are of special relevance to this institutional section of the report are the Puerto Rico Energy Office (PREO) and the Water Resources Authority (WRA).

The WRA (or, AFF: Autoridad de las Fuentes Fluviales de Puerto Rico) is both the insular power authority and public utility. The Authority also is in charge of operation at the proposed Patillas site. It will be a vital part of any successful project for power generation in Puerto Rico.

The WRA is a governmental instrumentality created by the government of Puerto Rico and subject to its own Executive Board. That board is made up of seven members, five of whom are appointed by the Governor and two who are elected at large by the power consumers of Puerto Rico. While subject, as provided by the establishing legislation, to the control of "certain officers of the Commonwealth government" (i.e., those who

make up the Board), the WRA is a corporation which has a legal existence and personality separate and apart from that of the government. Therefore, all debts, obligations, contracts, bonds, notes, debentures, receipts, expenditures, accounts, funds, undertakings and property of the Authority are those of this government-controlled corporation, but not those of the Government, per se. While it would be an error to conceive of the WRA or of WRA policy as being automatically reflexive to administration planning and policy, it is reasonable to conclude that the Authority is sensitive and responsive to those plans and policies as expressed by the Office of the Governor.

It is the WRA Executive Board which has the final authority on all projects which fall under the purview of the Authority. These include all programs for power generation on the island.

The Puerto Rican government is naturally vitally interested in the application of new technologies to the development of renewable natural resources. The island's virtual dependence (currently, 97% of Puerto Rico's power needs are supplied by foreign crude at $14/bbl., a price which does not take into account recently announced OPEC price increases nor the $20/bbl. spot prices being obtained as a result of the Iranian curtailment of exports) upon imported petroleum for its energy needs is a prime reason for that interest. The Government's interest in such projects is reflected in such projects as the wind turbine generator project sited on the island of Culebra, as well as by its responsiveness to the possibilities of the project represented by this study. The WRA is under contract to the United States Department of Energy for testing and operation of the wind turbine project, and it is necessary that the Authority be involved in any program of hydropower generation undertaken at Patillas, or other, sites. The study team anticipates WRA

interest in projects of the kind described by this study for the following reasons:

1) It is part of the Authority's charter, under the governing laws of Puerto Rico, to be charged with, "conserving, developing and utilizing... (the) water and energy resources of Puerto Rico."

2) The WRA has strongly expressed its responsibility, "to search for lower price energy sources in order to benefit our consumers."

3) The WRA has indicated interest in assessments which produce useful information to support its plans for the intensive use of Puerto Rico's renewable energy resources.

4) The WRA has expressed to this study team that it is, "the entity capable of actual development and operation of hydroelectric facilities in Puerto Rico."

We find it wholly appropriate for the WRA to execute projects such as the one identified at Patillas (when they are found to be feasible and desirable) and the Authority has consistently stated its interest in such projects. Such a role is in keeping with the WRA's traditional responsibilities, as well as with its response to the Interim Report issued by this study team (See Appendix, "Comments of the Puerto Rico Water Resources Authority to the Interim Report on the Hydroelectric Feasibility Assessment of Patillas Reservoir, Puerto Rico.").

The WRA has strongly expressed itself as an agency vitally concerned with the energy needs of Puerto Rico and with providing power to its consumers at the lowest possible cost. Consistent with this, the Authority has undertaken initiatives or studies in the areas of geothermal, wind, ocean thermal and solar radiation power generation. This interest and determination can easily and naturally be extended to hydropower, an area in which the Authority has both long-term and current operating experience.

At one time most of Puerto Rico's electricity was produced through hydropower generation, however the ready availability of cheap crude oil and of reasonably efficient power

generation technologies such as steam and gas turbines, along with rapidly increasing demand, led to a diminution of the importance of hydropower in Puerto Rico. As operations and maintenance (O&M) costs increased, absolute levels of hydropower production in Puerto Rico actually decreased while overall power production was rising dramatically.

Several small hydropower sites on the island were classified as uneconomic and shut down during 1964 - 1970. Discussions with WRA technical personnel have indicated that high O&M costs were the rationale for the closures. There was insufficient economic incentive to seriously consider modernization of facilities at a time when crude oil was cheap and easily obtainable.

During the period under discussion, Puerto Rico was able to purchase crude for an average price of $1.60/bbl. Currently, the price paid for primarily Venezuelan crude is $14.43/bbl. (This price does not reflect recent increases, but is the figure used for economic feasibility determination by this study.) This price rise reflects the new reality of the price of energy in Puerto Rico and the rest of the world, and should serve to indicate the need for viewing energy-related problems and possible solutions in new ways.

The meteoric escalation in the price of crude, the economic impacts which have accompanied that rise and the predictable long-term scarcity of oil resources all contribute to a new economics of energy. It is obvious that a rise of almost 1000% in the cost of oil has the effect of making some processes and operations more cost-effective vis-a-vis oil than was once the case. So do recent advances in alternative technologies, including hydropower systems with automatic controls and closed or water-lubricated bearings which drastically reduce O&M costs.

Less obvious, but as relevant to any discussion of the ranking of energy priorities, are the side effects of not exercising non-oil options.

Because dependency on oil for energy generation has such marked effects on populations and economies in today's world, it can be argued that traditional methods of straight calculation of return-on-investment (ROI) are no longer completely relevant in making energy use decisions. The large scale purchase of foreign oil has ripple effects on an economy which go far beyond simple cost-per-barrel calculations. Thus, to demand traditional ROI yields before committing to non-oil energy operation systems such as hydropower is basically to oversimplify a complex problem.

There is a recognition of this within the WRA. The Authority has stated that, "Energy use decisions made by PRWRA are based on the government policy which is established for the benefit of our consumers." The emphasis of this statement, given in response to the study team's comments about traditional economic modes of ROI determination and ranking, seems to emphasize the WRA's rejection of outmoded evaluation methodology.

It seems evident that Puerto Rico's hydropower resources, if totally developed, could be expected to supply no more than a fraction of maximum 1978 peak demand load of 2012MW, but that is a capacity well worth developing. It is a contribution which would significantly lower the island's strategic vulnerability and dependence upon outside sources, which should serve as an uninterruptable basic power supply during extreme emergency, and which could help to slow the rise of the already extremely high KW-Hour costs to the Puerto Rican consumer. Such results can be seen as advantageous politically, economically and socially. Potential hydropower generation sites such as Patillas which have been found to be economically and tech-

nically feasible for power generation represent the class of projects to which the Puerto Rican government and the WRA have an expressed committment. Because that is the case, no institutional barriers to the implementation of such projects are perceived in the Puerto Rican case.

During this feasibility study, the study team has had extensive dealings with the PREO, gaining information and much valuable insight into the specific situation at Patillas and in Puerto Rico in general. The PREO is vitally interested in renewable resource exploitation through the application of new technologies such as hydropower, and has served as lead institution within Puerto Rico during this feasibility study.

Because of the automatic operation of the proposed hydropower installation at the Patillas site, there had been some question about the response of the Union de Trabajadores Industrias de Electrica y Riego (UTIER) to the project. WRA representatives have assured the study team that the union has no standing in regard to projects which fail to create long-term employment. Because the Patillas project would create some short-term jobs in the construction trades, while not supplanting positions within the UTIER, no problem in this area is anticipated.

Some question has been raised about the need for a permanent caretaker/technician at the proposed hydropower installation. Because the nature of the proposed installation does not require a technician in attendance, the issue simply becomes one of whether the site must be guarded against possible vandalism.

An attendant is already present at the proposed earth dam site (the spillway location has no caretaker, so apparently

8.2 INSTITUTIONAL CLIMATE (cont'd)

reactive measures to counter vandalism are uneven or the problem has been overstated) on a 40/hour-a-week shift, and the study team sees no justification for additional expenditure in this area. The proposed construction of a powerhouse structure around the equipment should provide ample protection against casual vandalism, in concert with the presence of the caretaker.

8.3 SOCIAL CLIMATE

We have found no reasons to suppose any serious social barriers to the implementation of widespread hydropower development in Puerto Rico. On the contrary, the social implications of such a program are seen as being highly favorable, implying as they do a cheaper, cleaner, more secure form of power generation, and some additional construction trades employment in rural areas of high unemployment.

The high purchase price of electricity on the island (industries - $0.04025/KHW; municipalities (public lighting) - $0.117/KWH; municipalities (offices) - $0.065/KWH) argues strongly for a less expensive source of power. The very real possibility of an interruption in the petroleum supply adds to the power of that argument. The generation of cheaper power from an indigenous renewable resource is not a difficult concept to put across in a social context.

There are individual situations of a site-specific nature which must be taken into account when planning hydropower development at individual sites. Such impoundments are utilized for irrigation and potable water supply, as well as for flood control and, occasionally, recreation. In the case of the Patillas site, there are irrigation demands which vary between 70-105CFS.

8.3 SOCIAL CLIMATE (cont'd)

While the majority of the outflow from Lake Patillas is used to irrigate the sugar cane fields along the south coast, new uses may occur in the future. Cane cultivation is decreasing due to the steady drop in world sugar prices, and there has been discussion in regard to converting some cane acreage to rice or vegetable farming. The latter, in particular, is seen as a valuable crop in the Puerto Rican context. Regardless of cropping decisions, however, overall use of water from the Patillas impoundment is seen as rising, due both to agricultural use and to population increase. The requirements of hydropower production at the Patillas site are not seen as impacting upon these water use requirements, and, in fact, can only be benefited by them.

Extensive inquiry has noted no likelihood of localized resentment to the type of project envisioned by this study. In fact, individualized contacts with local landowners have been overwhelmingly positive. However, in order to have the most favorable impact upon the area, it is recommended that local labor and contractors be utilized during the construction stage wherever practicable.

APPENDIX I

To Section 6: LEGAL AND REGULATORY FEASIBILITY

SECTIONS OF THE LAWS OF PUERTO RICO PERTINENT TO HYDROELECTRIC POWER DEVELOPMENT AND AGENCY ROLES AND RESPONSIBILITIES

§ 193. Creation and composition of Authority

(a) The Governor or Puerto Rico, the Secretary of Public Works of Puerto Rico, and the Secretary of Agriculture and Commerce of Puerto Rico are hereby created a body corporate and politic constituting a public corporation and governmental instrumentality of the Commonwealth of Puerto Rico by the name of the "Puerto Rico Water Resources Authority." Said Members of the Authority shall be entitled to no compensation for their services as Members.

(b) The Authority hereby created is and shall be a governmental instrumentality subject, as provided herein, to the control of certain officers of the Commonwealth Government, namely the Governor, Secretary of Public Works and Secretary of Agriculture and Commerce acting in their capacity as the Members and Governing Board thereof but it is a corporation having legal existence and personality separate and apart from that of the government and those of the officers so controlling it. The debts, obligations, contracts, bonds, notes, debentures, receipts, expenditures, accounts, funds, undertakings, and property of the Authority, its officers, agents or employees shall be deemed to be those of said government-controlled corporation and not to be those of the Commonwealth Government or any office, bureau, department, commission, dependency, municipality, branch, agent, officer or employee thereof. — May 2, 1941, No. 83, p. 684, § 3; Apr. 8, 1942, No. 19, p. 330, § 1; Const., art. I, § 1, art. IX, § 4; July 24, 1952, No. 6, p. 10, eff July 25, 1952.

HISTORY

Codification. "People" and "Insular" were changed to "Commonwealth" pursuant to the Constitution. "Commissioner of the Interior" was changed to "Secretary of Public Works", and "Commissioner of Agriculture and Commerce" was changed to "Secretary of Agriculture and Commerce" pursuant to Act July 24, 1952, No. 6.

Department of Commerce. See sections 431–440 of Title 3, and Const. art. IX, § 8.

§ 196. Powers of the Authority

The Authority is created for the purpose of conserving, developing, and utilizing, and aiding in the conservation, development, and utilization of water and energy resources of Puerto Rico, for the purpose of making available to the inhabitants of the Commonwealth, in the widest economic manner, the benefits thereof, and by this means to promote the general welfare and increase commerce and prosperity; and the Authority is granted and shall have and may exercise all rights and powers necessary or convenient for the carrying out of the aforesaid purposes, including (but without limiting the generality of the foregoing) the following:

(a) To have perpetual existence as a corporation;

(b) To adopt, alter, and use a corporate seal, which shall be judicially noticed;

(c) To prescribe, adopt, amend, and repeal bylaws governing the manner in which its general business may be conducted and the powers and duties granted to and imposed upon it by law may be exercised and performed;

(d) To have complete control and supervision of any undertaking constructed or acquired by it including the power to determine the character of and necessity for all its expenditures and the manner in which they shall be incurred, allowed and paid without regard to the provisions of any laws governing the expenditure of public funds, and such determination shall be final and conclusive upon all officers of the Commonwealth Government, and to prescribe, adopt, amend, and repeal such rules and regulations as may be necessary or proper for the exercise and performance of its powers and duties or to govern the rendering of service or sale or exchange of water or electric energy;

(e) To sue and be sued, implead and be impleaded, complain and defend, in all courts;

(f) To make contracts and to execute all instruments necessary or convenient in the exercise of any of its powers;

(g) To prepare, or cause to be prepared, plans, designs, and estimates of costs for the construction, reconstruction, extension, improvement, enlargement, or repair of any undertaking or any part or parts thereof, and from time to time to modify such plans, designs, and estimates;

(h) To acquire in any lawful manner including, but without limitation, acquisition by purchase, whether by agreement or by the exercise of the power of eminent domain, lease, bequest, devise, gift, and to hold, maintain, use and operate any undertaking or parts thereof;

(i) To acquire in the manner set forth in subsection (h) hereof, produce, impound, develop, manufacture, treat, hold, conserve, use, transmit, distribute, supply, exchange, sell, rent and otherwise dispose of, water, electric energy, equipment, and such other things, supplies and services as the Authority shall deem necessary, proper, incidental, or convenient in connection with its activities; Provided, That in disposing at wholesale of electric energy the Authority shall give preference and priority as to supply to public bodies and cooperatives;

(j) Acquire in the manner set forth in subsection (h) hereof and to hold and use any property, real, personal, or mixed, tangible or intangible, or any interest therein, deemed by it to be necessary or convenient for carrying out the purposes of the Authority, and (subject to the limitations contained in sections 191–217 of this title) to lease as lessor, or exchange, any property or interest therein at any time acquired by it;

(k) To construct or reconstruct any undertaking or any part or parts thereof, and any additions, improvements, and extensions to any undertaking of the Authority by contract or contracts, or under, through, or by means of its own officers, agents, and employees;

(l) To determine, fix, alter, charge, and collect reasonable rates, fees, rentals, and other charges for the use of the facilities of the Authority, or for the services, electric energy, or other commodities sold, rendered, or furnished by it, which shall be sufficient for the payment of the expenses of the Authority incurred in the conservation, development, improvement, extension, repair, maintenance, and operation of its facilities and properties, for the payment of the principal of and interest on its bonds, and for fulfilling the terms and provisions of such covenants as may be made with, or for the benefit of, the purchasers or holders of any bonds of the Authority; Provided, That, in fixing rates, fees, rentals, and other charges for electric energy, the Authority shall have in view the encouragement of the widest economically possible diversified use of electric energy; and that before changes in the general rate structure for the sale of electric service are made, or, in cases where the Board shall decide to make changes and deems the immediate effectiveness thereof to be necessary, then within a reasonable time after such changes are made, a public hearing shall be held with respect thereto before the Board of the Authority, or before such hearing officer or officers as the Board may designate, and upon such hearing, the Board, pursuant to the powers, duties, and obligations vested in it by sections 191–217 of this title, may alter, suspend or revoke such changes;

(m) To appoint such officers, agents, and employees and vest them with such powers and duties, and to fix, change, and pay such compensation for their services as the Authority may determine;

(n) To borrow money, make and issue bonds of the Authority for any of its corporate purposes, and to secure payment of its bonds and of any and all other obligations by pledge of or lien on all or any of its contracts, revenues, and income only;

(o) To make and issue bonds for the purpose of funding, refunding, purchasing, paying, or discharging any of the outstanding bonds or obligations issued or assumed by it or any bonds or obligations the principal or interest of which is payable in whole or in part from its revenues;

(p) To accept grants from, and enter into contracts, leases, agreements, or other transactions with, any Federal agency, the Commonwealth of Puerto Rico, or political subdivisions of the Commonwealth of Puerto Rico, and to expend the proceeds of any such grants for any corporate purposes;

(q) To sell, or otherwise dispose of, any property of any kind, real, personal, or mixed, or any interest therein, that in the judgment of the Board is no longer necessary for carrying on the business of the Authority or for effectuating the purposes of sections 191–217 of this title;

(r) To enter on any lands, waters, or premises, after notifying the owners or holders thereof, or their representatives, for the purpose of making surveys, soundings, or examinations;

(s) To do all acts and things necessary or convenient to carry out the powers granted to it by sections 191–217 of this title or by any other Act of the Legislature of Puerto Rico, or by any Act of the Congress of the United States; Provided, however That the Authority shall have no power at any time or in any manner to pledge the credit or taxing power of the Commonwealth of Puerto Rico or any of its political subdivisions, nor shall the Commonwealth of Puerto Rico or any of its political subdivisions be liable for the payment of the principal of or interest on any bonds issued by the Authority. — May 2, 1941, No. 83, p. 684, § 6; Apr. 8, 1942, No. 19, p. 330, § 1; Const., art. I, § 1, art. IX, § 4, eff. July 25, 1952.

HISTORY

Codification. "Island", "Insular", and "People" were changed to "Commonwealth" pursuant to the Constitution.

Text of regulations. For the text of regulations authorized by this section, see section 196-1 et seq. of Title 22, Rules and Regulations of Puerto Rico.

Cross references. Procedure for condemnation of property, see 1958 Civil Procedure Rules 58.1–58.10, Title 32 App.

ANNOTATIONS

1. **Donations.** The power of the Puerto Rico Water Resources Authority for accepting gifts, as well as the power of the Governor or the Secretary of Public Works for accepting gifts in the name of such authority in relation to the Southwestern Puerto Rico Project (Lajas Valley Project) is contained in Acts No. 83 of 1943 (section 1191 et seq. of this title), No. 23 of 1952 (section 361 et seq. of this title), and No. 65 of 1953 (section 341 et seq. of this title), and said power is not limited by the proviso contained in section 1101 of Title 3 which states that gifts may only be accepted when they come from nonprofit institutions. 1960 Op. Sec. Jus. No. 58.

The Puerto Rico Water Resources Authority can accept a donation even if it is coming from profit institutions, but subject to the condition that the properties thus acquired be used for the purposes of the Southwestern Puerto Rico Project or Lajas Valley Project. Id.

§ 197. Officers and employees

(a) Appointments, removals, promotions, transfers, discontinuances, reinstatements, suspensions, leaves of absence and changes in grade, compensation or title of the officers and employees of the Authority shall be made and permitted as provided in rules and regulations to be prescribed by the Board in pursuance of a general plan similar, insofar as the Board shall deem it consistent with the best interests of the Authority, of its employees and of its service to the public, to that which may be in effect for employees of the Commonwealth Government under the Personnel Act, sections 641–678 of Title 3. The members, officers, and employees of the Authority shall be entitled to reimbursement for, or per diem payment in lieu of, such necessary travel expenses as shall be authorized or approved pursuant to rules and regulations of the Board. Officers and employees of any board, commission, agency, or department of the Commonwealth of Puerto Rico may be appointed to similar positions in the Authority without examination. Any such Commonwealth officers and employees that shall have been so appointed who, prior to said appointment, were beneficiaries of any existing pension, retirement or savings and loan fund system or systems, shall continue to have, after said appointment, the rights, privileges, obligations, and status, with respect thereto that are prescribed by law for officers and employees holding similar positions in the Commonwealth Government, unless within six (6) months after this Act takes effect or six (6) months after said appointment, whichever is later, they or any of them shall signify the intention to relinquish them, in which case they shall then have those of resigned or separated officers or employees of the Commonwealth Government; and all employees so appointed to positions in the Authority who, at the time of their appointment, held or shall have held positions in the Commonwealth Government or any rights or status under the rules and classifications of the Puerto Rico Office of Personnel, shall have the same status with respect to employment or re-employment in the service of the Commonwealth Government as they had at the time they entered the service of the Authority or since better or higher right or status as the Office of Personnel shall consider to be consistent with advancement attained in the Authority. All officers and employees appointed to positions in the Authority, who, at the time of their appointment, had, or shall later acquire, some right or status under the rules and classifications of the Puerto Rico Office of Personnel for appointment to any similar position in the Commonwealth Government shall have, upon request, the same rights, privileges, obligations, and status, with respect to becoming beneficiaries of any existing pension, retirement or savings and loans fund system or systems, as if they had been appointed to similar positions in the Commonwealth Government. The Authority shall be subject to the provisions of sections 245–246m of Title 29.

(b) No person shall hold office as a Member, officer, employee, or agent of the Authority who has a direct or indirect financial interest in any privately owned public utility in Puerto Rico engaged in the production, distribution, or sale of electric energy, or in any

[illegible] Rico affiliated with or having [illegible] such [illegible] in Puerto Rico; or who has a [illegible] or indirect financial interest in any industrial or commercial enterprise engaged in the production, distribution, or sale of any commodity or service of a character commercially opposed to, or in competition in Puerto Rico with, the production, distribution, or sale of electric energy produced by hydroelectric means; Provided, That where such incompatibility affects a Member of the Authority, the position of such Member shall become vacant, and the vacancy so created shall be filled for the time that said incompatibility exists, by the appointment by the Governor of Puerto Rico of the head of any Department of the Commonwealth Government. — May 2, 1941, No. 83, p. 684, § 7; Apr. 8, 1942, No. 19, p. 330, § 1; May 12, 1947, No. 345, p. 594; Const., art. I, § 1, art. IX, § 4; June 26, 1956, No. 96, p. 622.

HISTORY

Codification. "People" and "Insular" were changed to "Commonwealth" pursuant to the Constitution. "Civil Service Laws of Puerto Rico" was changed to "Personnel Act, sections 641–678 of Title 3", and "Civil Service Commission" was changed to "Office of Personnel" pursuant to Act May 12, 1947, No. 345. Reference to "sections 211–241 of Title 29" was changed to "sections 245–246m of Title 29", pursuant to Act June 26, 1956, No. 96, p. 622.

Retirement or pension plans. The provisions of this section as to retirement or pension plans are affected by sections 218–220 of this title.

Cross references. All officials and employees of Puerto Rico Water Resources Authority in exempt service, see section 648 (a) (6) of Title 3.

Employees of Isabela Irrigation Service transferred to Puerto Rico Water Resources Authority, see section 236 of this title.

§ 198. Transfer of System of the Utilization of the Water Resources

There is hereby transferred and delivered, or there shall be so transferred and delivered to the Authority, all the property, real, personal, and mixed, tangible and intangible, of whatsoever kind and wheresoever situated, constituting the "System of the Utilization of the Water Resources" including all the funds, rights, franchises, privileges and assets of every character and description pertaining thereto, subject to all obligations and encumbrances, legal or equitable, with which the same may be burdened. — May 2, 1941, No. 83, p. 684, § 8; Apr. 8, 1942, No. 19, p. 330, § 1, eff. 90 days after Apr. 8, 1942.

HISTORY

Cross references. Effective date of transfer, see section 199 of this title.

§ 203. Acquisition of property by the Commonwealth for the Authority

Upon application of the Authority, the Governor of Puerto Rico or the Secretary of Public Works shall have power to purchase, either by agreement or by the exercise of the right of eminent domain, or by any other lawful means, title in the name and in behalf of the Commonwealth of Puerto Rico, to any property or interest therein which the Board of the Authority shall deem necessary or convenient for its purposes. The Authority may make available to said officers in advance such funds as may be needed for the payment of said property, and upon acquisition thereof, may reimburse the Commonwealth Government for any amount paid that shall not have been previously advanced. Upon such reimbursement to the Commonwealth Government (or, if the total cost or price has been previously advanced by the Authority, within such reasonable period as shall be determined by the Governor) the title to property so acquired shall pass to the Authority. The Secretary of Public Works may, with the approval of the Governor, make such arrangements as he may deem appropriate for the operation and control of said property by the Authority in behalf of the Commonwealth Government during the period intervening before said title has passed to the Authority. The power hereby conferred shall not limit or restrict in any manner or to any extent the power of the Authority itself to acquire property. The title to any property of the Commonwealth of Puerto Rico heretofore or hereafter acquired, and which shall be considered necessary or convenient for the purposes of the Authority, may be transferred to the Authority by the official in charge of said property or having the custody thereof, upon such terms and conditions as shall be determined by the Governor or the officer or agency designated by him. — May 2, 1941, No. 83, p. 684, § 13; Apr. 8, 1942, No. 19, p. 330, § 1; 1950 Reorg. Plan No. 12, §§ 1(7), 2; Const., art. I, § 1, art. IX, § 4; July 24, 1952, No. 6, p. 10, eff. July 25, 1952.

HISTORY

Codification. "People" and "Insular" were changed to "Commonwealth" pursuant to the Constitution. "Commissioner of the Interior" was changed to "Secretary of Public Works" pursuant to Act July 24, 1952, No. 6. "Executive Council" was changed to "Governor or the officer or agency designated by him" pursuant to 1950 Reorg. Plan No. 12, §§ 1(7), 2.

Cross references. Procedure for condemnation of property, see 1958 Civil Procedure Rules 58.1–58.10, Title 32 App.

§ 205. Construction and purchase contracts

All purchases and contracts for supplies or services, except for personal services, made by the Authority, including contracts for the construction of works of the Authority, shall be made after advertisement for bids sufficiently in advance of opening bids for the Authority to secure appropriate notice and opportunity for competition; Provided, That where the expense estimated to be necessary in connection with the purchase or work does not exceed one thousand (1,000) dollars, the same may be carried out without advertisement for bids. Advertisement for bids shall not be required, however, when (1) an emergency requires immediate delivery of the materials, supplies, equipment, or performance of the services; or (2) repair parts, accessories, or supplemental equipment or services are required for supplies or services previously furnished or contracted for; (3) professional or expert services or work are required and the Authority shall deem it best in the interest of good administration that contracts therefor be made without such advertisement; or (4) prices are noncompetitive because there is only one source of supply or because regulated under law; in any such case the purchase of such materials, supplies, or equipment, or procurement of such services, may be made in the open market in the manner usual in commercial practice. In the comparison of bids and the making of awards, due consideration shall be given to such factors (in addition to whether the bidder has complied with the specifications) as the bidder's ability to perform construction work of the kind involved in the construction contract under consideration; the relative quality and adaptability of materials, supplies, equipment, or services; the bidder's financial responsibility, skill, experience, record of integrity in dealing, and ability to furnish repair and maintenance services; and the time of delivery or performance offered. The Authority may prescribe rules and regulations for the submission of bids. — May 2, 1941, No. 83, p. 684, § 15; Apr. 8, 1942, No. 19, p. 330, § 1, eff. 90 days after Apr. 8, 1942.

§ 213. Declaration of public utility

For the purposes of subdivision (h) of section 196 and section 203 of this title, all works, projects, and property and their accessories, which the Authority may deem necessary and convenient to use in carrying out the purposes expressed in sections 191–217 of this title are hereby declared of public utility. — May 2, 1941, No. 83, p. 684, § 23; Apr. 8, 1942, No. 19, p. 330, § 1, eff. 90 days after Apr. 8, 1942.

§ 214. Coordination and integration of irrigation and hydroelectric projects

(a) With a view to the coordination and integration of irrigation and or hydroelectric projects and their activities, at present existing or that may be developed in the future, all powers, duties, functions, obligations, and responsibilities which prior to the enactment of sections 191–214 of this title were vested in, conferred or imposed upon the Chief Engineer of the Irrigation Service, the Secretary of Public Works and the Executive Council of Puerto Rico, or any of them under the Public Irrigation Law approved September 18, 1908, sections 251–259 of this title, and laws amendatory thereof or supplementary thereto, heretofore or hereafter enacted by the Legislature of Puerto Rico, providing for the construction and operation of a public irrigation system, and under those provisions of Act No. 58, approved April 30, 1928, applicable to the Hydroelectric System of the Puerto Rico Irrigation Service, South Coast, are hereby transferred to and conferred and imposed upon the Authority. The Authority shall administer said laws in conformity with the provisions thereof and shall be governed by them in the operation, maintenance, repair, reconstruction, construction of extensions, improvements, and enlargement of the works or systems constructed and operated and maintained pursuant to those laws; and to the extent that the exercise of such power does not impair the obligations of any contract of the Commonwealth of Puerto Rico, the Authority shall have power, notwithstanding anything to the contrary in said Act No. 58, to fix the basis for allocating operating expenses to the several systems operated by the Authority.

(b) In carrying out its duties under the next preceding paragraph, the Authority shall pay directly all costs and expenses incurred by it. The Authority shall be reimbursed for all such costs and expenses, including a fair share of the Authority's own overhead and operating expenses attributable to the Puerto Rico Irrigation Service, South Coast, as determined pursuant to subsection (a) above, from the funds available in the Commonwealth Treasury for the operation and maintenance, repair, reconstruction, construction of extensions, improvements and enlargements of the works or systems, constructed and operated and maintained pursuant to the Public Irrigation Law of 1908, approved September 18, 1908, sections 251–259 of this title and laws amendatory thereof or

supplementary thereto. There shall be advanced to the Authority, from time to time, from said Irrigation funds in the Treasury, amounts sufficient to provide a working fund adequate at all times to meet all of said costs and expenses promptly. Said funds shall be held and administered by the Authority in the same manner as its own funds but shall be used by it only for the payment of said costs and expenses.

(c) Upon authorization of the Legislature of Puerto Rico, the Authority, when it deems it advisable in the public interest, may take over and operate any irrigation and/or hydroelectric project existing and owned, or that may be developed or acquired in the future, by the Commonwealth of Puerto Rico. — May 2, 1941, No. 83, p. 684, § 24; Apr. 8, 1942, No. 19, p. 330, § 1; May 15, 1943, No. 191, p. 684; Const., art. I, § 1, art. IX, § 4; July 24, 1952, No. 10, p. 22; June 10, 1959, No. 27, p. 86, eff. June 10, 1959.

HISTORY

Codification. "People" and "Insular" were changed to "Commonwealth" pursuant to the Constitution. "Auditor" was changed to "Secretary of the Treasury" pursuant to Act July 24, 1952, No. 10.

Amendments — 1959. Subsec. (a): The 1959 Act amended subsec. (a) to substitute "Secretary of Public Works" for "Commissioner of Interior" and to delete requirement of prior approval of basis of allocation by Secretary of the Treasury.

Consolidation of hydroelectric systems. Act Apr. 30, 1928, No. 58, p. 412, referred to in this section, provided:

"Section 1. Pursuant to the plan of establishing interconnection among the different generating plants and electric power transmission and distribution systems which under the provisions of, and with funds created by, the laws of Porto Rico known as the Public Irrigation Law approved September 18, 1908 [sections 251–259 of this title], the Isabella Public Irrigation Law approved June 19, 1919 [sections 301–315 of this title], and the Act for the Development of the Water Resources, approved April 29, 1927 [see note under section 191 of this title], have been built and are owned and operated by the Insular Government, including such like plants and systems as it may hereafter build or acquire and place in operation, and in order that each of said systems may share the benefits derivable from a common organization and from a fuller and more diversified utilization of electric power under a general system for the island, the Commissioner of the Interior, subject to the provisions of this Act and when he deems it advisable, is hereby authorized to transfer and place all matters relative to the operation and service of each of said systems, including the generation, distribution and sale of electric power, as well as the surveys and technical direction of new constructions, extensions and improvements, under such direction and management as may have been organized to handle the activities created by the Act for the Development of the Water Resources, approved April 29, 1927.

"Section 2. All disbursements on account of maintenance and operation of the general system of generating plants and electric power transmission and distribution lines, including salaries of the directing, managing, office and technical personnel; of generating plants and sub-station operators, line patrolmen and other auxiliary personnel; cost of necessary materials and supplies, and in general, all such current expenses as may be necessary for said adequate maintenance and operation, shall be made directly out of the corresponding fund available to Utilization of the Water Resources, it being understood that in said expenses of maintenance and operation are comprised only such current expenses of inspection, cleaning and continuous attention to all parts of the equipment and of the works as may be necessary to repair the system from the current and natural effects resulting from the operation, but they do not include any extraordinary expenses of maintenance and repair required to extend the life of equipment and of the works, or to correct damages due to other causes not arising from the operation, or to restore parts which have been damaged or deteriorated by the elements. These extraordinary expenses shall be met in the manner hereinafter prescribed.

"To compensate and reimburse the Utilization of the Water Resources for such expenses as may be originated by the maintenance and operation of the aforesaid systems of the Government, each of said systems, namely, The Hydroelectric System of the Irrigation Service of the Southern Coast and Hydroelectric System of the Irrigation Service of Isabela, and in general, all other electric systems which may come into the possession of the Insular Government under some provision or fund distinct from those of the Act for the Development of the Water Resources, and that may be incorporated under the general system of the Island, shall pay monthly to the Utilization of the Water Resources for each kilowatt-hour distributed and sold within the operating district reserved for each system as described in detail in the following section, an amount which shall be fixed in accordance with the provisions of Section 5 of this Act.

"Section 3. The operating districts for each of the systems now constructed and under construction and in operation or proposed to enter into operation by the Insular Government, which are the Hydroelectric System of the Irrigation Service of the Southern Coast, constructed and operated in accordance with the Public Irrigation Law approved September 18, 1908, and the Hydroelectric System of the Irrigation Service of Isabela, constructed according to the Isabela Public Irrigation Act, approved June 19, 1919, are hereby established as limited by the boundaries which had heretofore been set for the operation of either system, to wit: The operating district for the Hydroelectric System of the Irrigation Service of the Southern Coast, comprising the municipalities of Maunabo, Patillas, Arroyo, Guayama, Salinas, Santa Isabel, Coamo, Juana Diaz and Villalba; and the operating district for the Hydroelectric System of the Irrigation Service of Isabela, comprising the municipalities of Hatillo, Camuy, Quebradillas, Isabela, Aguadilla, Aguada, Rincón and Añasco.

"Section 4. The Irrigation Service of the Southern Coast and the Isabela Irrigation Service shall each retain the ownership of the plant and equipment in their respective systems, and all extraordinary expenses for maintenance and repair not comprised within those which must be paid out of the fund for Utilization of Water Resources, as specified under Section 2 of this Act, as well as expenses for new constructions, enlargements, improvements and extensions of lines and branches within their respective districts of operation, shall be paid out of funds which each of said Services shall have available for such purposes. All expenses for surveys and for technical and administrative direction incurred by Utilization of the Water Resources to carry out the said repairs, new constructions, enlargements, improvements and extensions of lines and branches within the operating district of either Service shall be reim-

bursed out of the fund which each of said Services shall have available for such purposes.

"Section 5. Upon effecting the transfer of either system into the general system of the Utilization of the Water Resources, pursuant to the provisions of Section 1 of this Act, all sales of electric energy and power service within the respective operating district of the Hydroelectric System of the Irrigation Service of the Southern Coast and of the Hydroelectric System of the Irrigation Service of Isabela shall be made by Utilization of the Water Resources for account of each of said Services and in accordance with such tariff as shall be in force in the operating district of each respective Service; Provided, That all existing contracts for the supply of electric energy and power service coming from one or the other system herein mentioned and entered into between the People of Porto Rico and the respective consumers shall continue in force as though they had been originally entered into to cover the supply of energy and electric service from the general system of Utilization of the Water Resources.

"The receipts from the said sale shall be covered into the corresponding fund belonging to Utilization of the Water Resources, and each month Utilization of the Water Resources shall credit each service with the amount of the receipts derived from the sale of energy and electric power service within the respective operating district, after deducting and retaining from the amount of the said receipts for compensation and reimbursement, as stipulated in the second paragraph of Section 2 of this Act, a sum equal to the total number of kilowatt-hours sold and collected, multiplied by the amount to be retained for each kilowatt-hour, which amount shall be fixed as hereinafter determined; Provided, That in those cases where sales are made under monthly flat rate contracts, the number of kilowatt-hours to be considered in each case for purposes of this deduction and retention shall be the total number which in accordance with the rated capacity of the electric installation authorized in the contract may be consumed by the said installation operating twenty-four hours per day.

"The amount of receipts to be retained by Utilization of the Water Resources for each kilowatt-hour distributed and sold shall be fixed in the following manner:

"The Commissioner of the Interior shall prepare annually and shall submit to the Executive Council for approval, a budget of the necessary expenses for the maintenance and operation during the ensuing fiscal year, of the Hydroelectric System of the Irrigation Service of the Southern Coast, including in said expenses the salaries of the personnel directly engaged in the production, distribution, inspection and sale of electric energy within its operating district, plus the sundry expenses of materials and supplies required for the operation of the system, plus a part of the general expenses and salaries of the technical, administrative and office personnel of the organization of Utilization of the Water Resources which part shall be proportional to the volume of sales of electric energy estimated to be made within the district as compared with the total sales estimated to be made by the general system under the administration of the said Utilization of the Water Resources. The said budget shall also include an estimate of the number of kilowatt-hours expected to be the net production (after deducting the consumption of plant auxiliaries) of the generating plants owned by the Hydroelectric System of the Irrigation Service of the Southern Coast during the ensuing fiscal year. From this estimated net production there shall be deducted as probable losses in transmission, transformation and distribution twenty-five (25) percent and the seventy five (75) percent remaining shall constitute the number of kilowatt-hours by which shall be divided the total of the expenses included in the said budget, and the resulting quotient shall be the amount of receipts which shall be retained by Utilization of the Water Resources for each kilowatt-hour distributed and sold in the operating district of the Hydroelectric System of the Irrigation Service of the Southern Coast.

"Likewise, the Commissioner of the Interior shall prepare annually and shall submit to the Executive Council for approval, a budget of the necessary expenses for the maintenance and operation during the ensuing fiscal year, of the Hydroelectric System of the Isabela Irrigation Service, including in the said expenses the salaries of the personnel directly engaged in the production, distribution, inspection and sale of electric energy within its operating district, plus the sundry expenses for materials and supplies required for the operation of the system, plus a part of the general expenses and salaries of the technical, administrative and office personnel of the organization of Utilization of the Water Resources, which part shall be proportional to the volume of sales of electric energy estimated to be made within the district, as compared with the total sales estimated to be made by the general system under the administration of the said Utilization of the Water Resources. The said budget shall also include an estimate of the number of kilowatt-hours expected to be the net production (after deducting the consumption of plant auxiliaries) of the generating plants of the Hydroelectric System of the Isabela Irrigation Service during the ensuing fiscal year. From this estimated net production there shall be deducted as probable losses in transmission, transformation and distribution, twenty-five (25) percent and the remaining seventy-five (75) percent shall constitute the number of kilowatt-hours by which shall be divided the total of the expenses included in the budget, and the resulting quotient shall be the amount of receipts which shall be retained by Utilization of the Water Resources for each kilowatt-hour distributed and sold in the operating district of the Hydroelectric System of the Isabela Irrigation Service.

"Section 6. The electric energy imported from the general system of the Utilization of the Water Resources into the operating district of the Irrigation Service of the Southern Coast, and into the operating district of the Isabela Irrigation Service to supply the consumption that there may be in either district in excess of the production of its respective generating plants, shall be measured at the points where the lines of the system belonging to Utilization of the Water Resources connect with the lines of the system belonging to the Irrigation Service of the Southern Coast or of the Isabela Irrigation Service, as the case may be, and the value thereof shall be credited monthly from the respective Irrigation Fund to the Utilization of the Water Resources fund at a price per kilowatt-hour that shall be fixed by the Executive Council of Porto Rico.

"The electric energy from the Hydroelectric System of the Irrigation Service of the Southern Coast or from the Hydroelectric System of the Isabela Irrigation Service which shall be transmitted outside of the operating district of either Service into the general system of Utilization of the Water Resources to supply the demand of the system and at the same time to provide use for the excess production of their respective generating plants over what may be required to take care of the consumption in their respective operating districts, shall be measured at the points where the lines of the system belonging to Utilization of the Water Resources connect with the lines of the system belonging to the Irrigation Service of the Southern Coast or of the Irrigation Service of Isabela, as the case may be, and the value thereof shall be credited monthly from the Fund of Utilization of the Water Resources to

the respective Irrigation Funds at a price per kilowatt-hour that shall be fixed by the Executive Council of Porto Rico.

"Section 7. All Laws or parts of laws in conflict herewith are hereby repealed.

"Section 8. This Act shall take effect ninety (90) days after its approval."

Electric power system of Vieques. Act June 22, 1961, No. 110, p. 219, eff. July 1, 1961, provided for the conveyance of the electric power system of the island of Vieques to the Puerto Rico Water Resources Authority, with all property, rights and obligations, and provided the necessary funds for such conveyance.

Cross references. Conveyance to Puerto Rico Water Resources Authority of —

Hydroelectric System of Isabela Irrigation Service, see sections 232–237 of this title.

Hydroelectric System of Puerto Rico Public Irrigation Service, South Coast, see sections 228–231 of this title.

§ 228. Hydroelectric System of Puerto Rico Public Irrigation Service, South Coast, conveyed to Puerto Rico Water Resources Authority — Statement of motives

(a) The "Hydroelectric System of the Puerto Rico Public Irrigation Service, South Coast", includes the hydroelectric works and transmission and distribution lines and all facilities making up the electric power system constructed or acquired pursuant to the provisions of the Public Irrigation Law approved September 18, 1908, sections 251–259 of this title, and laws amendatory thereof or supplementary thereto, hereinafter referred to as the "Public Irrigation Act," and includes, also, all improvements, extensions and additions thereto constructed since the effective date of the Puerto Rico Water Resources Authority Act, sections 191–217 of this title, all of which shall hereinafter be collectively designated as "the Hydroelectric System," and all of which works, lines, facilities, improvements, extensions, and additions are now operated by the Puerto Rico Water Resources Authority, hereinafter designated as the "Authority," under the provisions of section 214 of this title, the books and accounts of the said System being kept separately by the Authority in accordance with the requirements of section 202 of this title.

(b) The operation by the Authority of the Hydroelectric System under the present set-up does not adequately meet the requirements of the district served by said System, and the integration of said System with the present electric properties of the Authority will provide the means, not otherwise available, for expanding and improving the properties now making up the Hydroelectric System and thus meeting the ever increasing demand for electric power service in the district.

(c) The conveyance of the Hydroelectric System to the Authority and its integration with the electric properties of the Authority will permit further expansion and improvement of the System so conveyed and will improve the electric power service in the district.

(d) The average annual net revenues deriving from the operation of the Hydroelectric System during the five fiscal years which ended on June 30, 1953, was approximately $200,000. These revenues have permitted the lowering of the amount of the special assessment levied on the lands included in the Irrigation District, South Coast. A sum corresponding to the said two hundred thousand (200,000) dollars will continue to be provided for the same purposes, pursuant to the provisions of sections 228–231 of this title. The operation of the Hydroelectric System by the Authority as an independent system, with its present limitations, will not produce in subsequent fiscal years average revenues in excess of the average annual net revenues derived during the five fiscal years which ended on June 30, 1953.

(e) When the Hydroelectric System is integrated with the electric properties of the Authority, the Authority shall, under the provisions of the Puerto Rico Water Resources Authority Act, sections 191–217 of this title, be under obligation to set aside, for payment into the Commonwealth Treasury, a sum equivalent to five (5) per cent of the gross revenues deriving from the sale of electricity to consumers in the municipalities included in the area of the Puerto Rico Public Irrigation Service, South Coast, which five (5) per cent is estimated at approximately fifty thousand (50,000) dollars. The Puerto Rico Public Irrigation Service, South Coast, has never had to pay that sum.

(f) When the conveyance of the Hydroelectric System to the Authority takes place, the setting aside and allocating of the sum of (1) $50,000 (the sum estimated in finding (e) above) as provided in section 230 of this title, and (2) the contributing by the Authority, from its revenues, of the annual sum of $150,000 as provided by section 230 of this title, will together equal the net receipts which would have resulted from the operation of the Hydroelectric System and which the Secretary of the Treasury would have had to use for determining the total amount of the special assessments to be levied on the lands at present included in the Irrigation District, South Coast, pursuant to the provisions of the Public Irrigation Act; sections 251–259 of this title.

(g) In the fulfilment of its duties under the provisions of section 241(b) of this title, the Authority has advanced to the Puerto Rico Public Irrigation Service, South Coast, funds, not as yet repaid, amounting to approximately $292,300 by the close of operations on June 30, 1954, and the value of the properties the title to which is vested in the Authority under the provisions of sections 228–231 of this title is far in excess of the amount so advanced.

(n) Under the provisions of the Puerto Rico Water Resources Authority Act, sections 191–217 of this title, the Authority may, whenever it deems it advisable in the public interest, take over and operate the Hydroelectric System upon the authorization of the Legislature of Puerto Rico.

(i) The Authority has found, and such findings have the approval of its Consulting Engineers, who were employed pursuant to the provisions of the Trust Indenture dated January 1, 1917 by and between the Authority and the First National City Bank of New York, (1) that in case the Authority issues its bonds under the provisions of said Trust Indenture in such an aggregate principal amount, bearing interest at such rate, and maturing on such dates as to render same equivalent to annual payments to the holders of such bonds, in the way of principal and interest, in the amount of $150,000 a year over a period of twenty (20) years (which is the annual burden imposed on the Authority by sections 228–231 of this title as an item of Operating Expenses to be paid by it), and sells such bonds at par in order to raise funds to acquire by purchase the Hydroelectric System, the purchase price of $150,000 a year for twenty (20) years would be a reasonable price to pay for said properties; (2) that the acquisition of the Hydroelectric System would, in the opinion of the said Consulting Engineers, preserve, develop and improve the "System" as such word is defined in said Trust Indenture; (3) that the additional annual revenues of the "System" (as so defined) will be at least $300,000 over and above the additional annual expenses resulting from such acquisition, figured as provided by section 209 of the said Trust Indenture; (4) that after adding such additional annual revenues to the average annual revenues of the "System", computed as provided in section 209(e)(i), the percentage obtained by dividing such total amount by the maximum amount of the principal and interest payable in any subsequent fiscal year on the score of all the bonds theretofore issued under the provisions of the said Trust Indenture and then outstanding and all such additional bonds as it might be required to be countersigned and delivered in order to obtain the money for the said purchase price of the Hydroelectric System, should same be purchased in this fashion, would not be less than one hundred and fifty percent (150%); (5) that the conveyance of the Hydroelectric System to the Authority under the provisions of sections 228–231 of this title and subject to the conditions hereof, in lieu of the purchase of the Hydroelectric System through the issuance and sale of bonds of the Authority, is acceptable to the Authority, the effect of such conveyance being, substantially, the same as if the Authority had issued its bonds for the acquisition by purchase of the Hydroelectric System and equally profitable to the Authority; and (6) that it is advisable in the public interest for the Authority to take over and operate the Hydroelectric System. — June 20, 1955, No. 83, p. 314, § 1, eff. July 1, 1955.

§ 229. — Conveyance and integration of Hydroelectric System; protection of irrigation rights

All property, real, personal, mixed, tangible and intangible, and all funds, appropriations, accounts, books, records, rights, franchises, contracts, obligations and privileges of whatever kind and description, appertaining to and making up the Hydroelectric System shall be conveyed and are hereby conveyed to and vested in the Authority, and on and after the effective date of such conveyance the said properties shall be integrated with the electric properties now owned by the Authority and shall thereafter be operated as an integral part thereof. The Registrars of Property shall, upon certification of the Authority approved by the Secretary of Public Works, register in the name of the Authority, fee free, the properties conveyed by sections 228–231 of this title. No provisions of sections 228–231 of this title shall in any wise affect the right of the lands served by the Puerto Rico Public Irrigation Service, South Coast, to receive water for irrigation purposes and to enjoy the benefits thereof in the same measure and to the same extent as they did prior to the approval of such sections, and such works of the Hydroelectric System hereby conveyed to the Authority as are jointly used for the storage and conveyance of water for irrigation purposes and for the generation of electric power shall remain affected with their obligation toward the said lands; Provided, however, That after such conveyance has taken place the Authority shall, once the provisions hereof are complied with, have the utilization and application of such waters for all such purposes as may be necessary for the exercising by the Authority of its powers under the Puerto Rico Water Resources Authority Act, sections 191–217 of this title. — June 20, 1955, No. 83, p. 314, § 2, eff. July 1, 1955.

§ 255. Entry upon and condemnation of property

The Puerto Rico Water Resources Authority, its officers, agents, or employees, shall have the right to enter, after notifying the owner or his representative, upon any lands to make surveys and to locate and establish any of the works contemplated or embraced in said irrigation system, including the lines of any canal, road, tunnel, reservoir site, aqueduct, power station, transmission lines or other requisite, but indemnity shall be paid to the owner for such damages as he may incur in consequence of said works. The Authority shall have power, when necessary, to initiate suits for condemnation in the name of the Commonwealth of Puerto Rico for the acquisition of any land or right embraced within the approved plans of the said irrigation project, and for the purpose of such condemnation proceeding all land and water rights, all rights of way for the transmission of water and electric currents, all sites for reservoirs, canals, roads, tunnels, aqueducts, ditches, power stations, and other things embraced in and contemplated by said irrigation plan so approved, are hereby declared to be works of public utility, and as such are hereby declared subject to the power of eminent domain and open to expropriation proceedings in the manner provided by law. Provided, however, that all said rights and things, together with any existing and outstanding water rights not theretofore surrendered to the Commonwealth of Puerto Rico may be made subject of condemnation proceedings without compliance with those provisions of law requiring a declaration of public utility by the Governor pursuant to sections 2902, 2905, 2906, 2911 and 2913 of Title 32, or any other provisions relating to declarations of public utility and provided, further that the Authority shall at all times have authority to acquire for said irrigation system such rights and things wherever possible, by settlement out of court to avoid condemnation proceedings. — Sept. 18, 1908, p. 152, § 12; May 2, 1941, No. 83, p. 684, § 24; 1950 Reorg. Plan No. 12, § 1(12); Const., art. IX, § 4, eff. July 25, 1952.

HISTORY

Codification. "People" was changed to "Commonwealth" pursuant to the Constitution. "Executive Council" in first proviso was changed to "Governor" pursuant to 1950 Reorg. Plan No. 12, § 1(12). "The irrigation engineer herein provided, his" was changed to "The Puerto Rico Water Resources Authority, its". "Commissioner of the Interior" was changed to "Authority", and "Executive Council" in last proviso was changed to "Authority" pursuant to Act May 2, 1941, No. 83, § 24, as amended, section 214 of this title.

Cross references. For more recent provisions concerning entry upon and condemnation of property see sections 196 and 203 of this title.

§ 258. Water power developed in connection with irrigation

Should a potential water power be developed in connection with the construction of the Irrigation system, the Puerto Rico Water Resources Authority is hereby authorized to arrange for the utilization and exploitation thereof as an integral part of the said irrigation system, to the best advantage, either by administration or under franchise to private parties, giving preference in this case to the municipalities and to the property owners comprised in the Irrigation District.

All profits accruing from said power shall be covered into the Irrigation Fund and applied to the decrease of annual assessments until all indebtedness incurred on behalf of the irrigation system has been fully paid, but the right and title to such water power shall remain in the Commonwealth Government, and the income from said work, after all indebtedness has been paid, shall be covered into the Commonwealth Treasury as Commonwealth Revenues until further provision shall have been made by the Legislative Assembly. — Sept. 18, 1908, p. 152, § 29; May 2, 1941, No. 83, p. 684, § 24; Const., art. I, § 1, eff. July 25, 1952.

HISTORY

Codification. "Insular" was changed to "Commonwealth" pursuant to the Constitution. "Executive Council" was changed to "Puerto Rico Water Resources Authority" pursuant to Act May 2, 1941, No. 83, § 24, as amended, section 214 of this title.

APPENDIX II

To Section 6: LEGAL AND REGULATORY FEASIBILITY

FEDERAL ENERGY REGULATORY COMMISSION ORDER No. 11
"SHORT FORM" LICENSING AND EXEMPTIONS

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

(18 CFR §§3.114(b), 4.60, 16.12, 131.6)

Before Commissioners: Don S. Smith, Acting Chairman;
Georgiana Sheldon, and George R. Hall.

Short-Form License (Minor)) Docket No. RM78-9

ORDER NO. 11

SIMPLIFIED PROCEDURES FOR
CERTAIN WATER POWER LICENSES

(Issued September 5, 1978)

The Federal Energy Regulatory Commission (Commission) gives notice that it is amending the General Rules and Regulations under the Federal Power Act, Subchapters A, B, and D, Chapter I, Title 18, Code of Federal Regulations. These amendments establish a short-form water power license (minor) and a new application form with accompanying instructions for completing the application for a short-form license (minor).

As stated in the Notice of Proposed Rulemaking, 43 F.R. 18196 (April 28, 1978), the purpose of these amendments is to provide a simplified procedure and format for processing applications for small-scale water power projects. This procedure should save time for the applicant and the Commission Staff, as well as to eliminate unnecessary obstacles to the development of small capacity water power projects, in furtherance of national policies for conservation of fossil fuels. 1/

The number of inquiries received by Commission staff in recent months concerning the installation of additional generating capacity at existing water power projects, the

1/ For example, the National Energy Act proposals now under consideration by a Joint Conference Committee of the United States Senate and House of Representatives include a program for loans, encouragement, and expeditious licensing for certain hydroelectric projects with no more than 20,000 HP (15 megawatts) installed capacity.

redevelopment of existing projects to provide additional power, and the installation of power generating facilities at existing non-power dams has increased sharply. This interest has been accompanied by a substantial increase in the number of applications filed with the Commission.

The proposed rulemaking would have imposed three eligibility criteria for a project to obtain a short-form license (minor). These were: (1) the project dam or diversion structure could be no more than 25 feet in height above stream bed; (2) the project could not impound a reservoir having a surface area of 10 acres or more; and (3) the project generating capacity could not exceed 2,000 horsepower (1,500 kilowatts). After examining the comments, reevaluating the criteria, and considering the legal and policy questions involved, the Commission has decided to eliminate the first and second limiting criteria to widen the applicability of the short-form license (minor) procedure to all projects having a generating capacity of 2,000 HP (1,500 kW) or less (that is, all "minor" projects).

In response to the notice, 18 entities and 1 individual submitted comments for Commission consideration. 2/ The

2/ Letters of comments were received from: Southern California Edison Company; the Salt River Project; the New England Energy Task Force; the New England Regional Energy Advisory Board; the New England States Commissions; the National Rural Electric Cooperative Association; the Straflo Group; American Public Power Association; Central Vermont Public Service Corporation; LeBoeuf, Lamb, Leiby & MacRae; Power Authority of the State of New York; Robert J. Taylor; the U. S. Department of the Interior, Heritage Conservation and Recreation Service; Central Maine Power Company; Duke Power Company; Maine Hydroelectric Development Corporation; the Mead Corporation; Allegheny Power Service Corporation; and Linton, Mields, Reisler & Cotton, Ltd.

comments were generally favorable to the proposal, but most also expressed the view that the criteria used were far too restrictive, and should be expanded so that more applications could be processed under the streamlined procedure.

One common suggestion was that the generation limit be raised from 1,500 kW (1.5 MW) to 15 MW. The latter figure is the upper limit selected for the small hydroelectric project incentive program included in the National Energy Act now pending in Congress. These short-form license (minor) procedures are specifically intended to apply only to minor projects, those with installed capacity of 2,000 HP or less (i.e., 1.5 MW), for which the Commission may waive certain provisions of the Federal Power Act, as authorized in Section 10(i), 16 U.S.C. §803(i). But the Commission intends to simplify its hydroelectric licensing procedures for major projects as well. Its staff is currently reviewing these procedures and developing recommendations for the Commission's consideration. Thus, future rulemakings will propose additional simplified licensing procedures for major projects between 2,000 HP and 20,000 HP (15 MW), as well as for major projects larger than 20,000 HP, in generating capacity.

Another suggestion common to many of the comments was that the height limitation be increased from 25 feet to 66 feet (20 meters). The higher figure is used by the Department of Energy in its Program Research and Development Announcement (PRDA), ET-78-D-07-1706. The 25-foot limitation was originally selected because it corresponded to the dam height set by Congress in the National Dam Inspection Act, 33 U.S.C. §467a-467e, as the upper limit for dams to be considered in a "low hazard" category. Comments generally pointed out that any size limitation based on safety reasons was irrelevant because at the time of licensing the Commission must find all dams

safe and adequate, or capable of being made safe by taking appropriate action as spelled out in the licensing order and instrument. The Commission agrees and also notes that, for an existing but unlicensed project which is subject to our jurisdiction, the public health, safety, and welfare are better served by procedures which allow the swift issuance of a license for that project, but requiring the owner to take actions to make the project safe under penalty of law, than by a more cumbersome and lengthy licensing process required by a dam height limit. Thus, the Commission is eliminating the dam height criterion.

The final suggestion common to many of the comments was that the 10-acre reservoir size limitation was too restrictive. This limitation was based upon Section 2 of the Fish and Wildlife Coordination Act (FWCA). 3/ Upon further review, the Commission concludes that the consultation requirements of the FWCA will be satisfied by its solicitation of the relevant federal and state agencies' comments by means of forwarding to those agencies a copy of the public notice of the application for license. The public notices, which are issued pursuant to the Federal Power Act, 4/ will explicitly solicit comments. The Commission also notes that these federal and state agencies are given a prior opportunity for comment and input on the proposed project very early in the process, because the short-form procedures require the applicant to consult with these agencies and include evidence of such consultation as part of the application submitted to the Commission. Furthermore, the agencies may obtain copies of the application from the Commission or the applicant upon request. Therefore, the Commission has decided to eliminate

3/ 16 U.S.C. §662.

4/ 16 U.S.C. §797(e) and (f).

the criterion relating to reservoir size for projects that would otherwise be eligible for a short-form license (minor).

Finally, some comments suggested certain other changes in the new procedures -- such as making them applicable to applications for relicensing and requiring only that a water quality certificate be applied for at the time of license application to this Commission, rather than be included with the short-form application. Those and other minor suggested changes have been made. In addition, the Commission is extending the new procedure to qualifying existing license applications already on file, as well as to future filings.

As a result of the changes discussed above, all existing "minor" license applications will be processed under the new short-form license (minor) procedures. Thus, the amendments to Commission regulations made below generally delete the existing sections dealing with "minor" licenses and substitute new sections for short-form licenses (minor). While some section numbers may thus be different from those in the notice of proposed rulemaking, the sections themselves are essentially the same.

The short-form license (minor) procedures in the notice of proposed rulemaking also contained proposed new Forms L-22 and L-23, which were license order formats containing, inter alia, standard license articles. The expansion of the short-form license (minor) procedures to cover all minor projects obviates the need for any new forms. For standard license articles for short-form licenses (minor), the Commission will select the appropriate form from the current Forms L-9, L-12, and L-14 through L-19 (revised October, 1975) applicable to minor projects. /See 18 CFR §2.9 and Order No. 540, 40 F.R. 51998 (November 7, 1975)/ For information, a typical format for a short-form license (minor) is attached as Appendix A to this order.

The Commission is making these amendments effective immediately. Because the amendments reduce the filing requirements in a certain type of application, they involve a substantive rule which relieves a restriction and are not required to be published thirty days prior to their effective date.

(Federal Power Act, as amended, 16 U.S.C. §§792 et seq., Department of Energy Organization Act, Pub. L. 95-91, E.O. 12009, 42 F.R. 46267.)

For the reasons stated above, Parts 3, 4, 16, and 131 of Chapter I, Title 18, Code of Federal Regulations, are amended as set forth below, effective immediately.

By the Commission.
(S E A L)

Kenneth F. Plumb,
Secretary.

1. Section 3.114 is amended by revising paragraph (b) to read:

§3.114 Licenses

* * * * *

(b) Applications under the Federal Power Act for license authorizing construction of projects; for license for constructed projects; and for renewal of licenses for projects are processed in the manner stated in §3.113.

* * * * *

2. Part 4 is amended by revising §4.60 to read:

§4.60 Contents

Each application for a short-form license (minor) for a water power project having installed capacity of 2,000 horsepower (1,500 kW) or less, whether constructed or to be constructed, shall conform to §131.6 of this chapter and shall be filed in accordance with §4.31 of this chapter.

3. Part 16 is amended by revising §16.12 to read:

§16.12 Renewal of minor or minor part license or short-form license (minor) not subject to sections 14 and 15

A licensee whose minor or minor part license or short-form license (minor) is not subject to sections 14 and 15 of the Act and who wishes to continue operation of the project after the end of the license term shall file an application for a "new license" 1 year prior to the expiration of the original license in accordance with applicable provisions of Part 4 of this chapter. Each application for new license under this section shall conform to §131.6 of this chapter, and shall set forth all information and exhibits prescribed in §4.60 of this chapter.

4. Part 131 is amended by revising §131.6 to read:

§131.6 Application for Short-Form License (Minor)

(See Section 4.60 of this chapter.)

Docket No. RM78-9

APPLICATION FOR SHORT-FORM LICENSE (MINOR)

1. Applicant's full name and address: _____

_____
(Zip Code)

2. Location of Project:

State: _____ County: _____

Nearest town: _____ Water body: _____

3. Project description and proposed mode of operation (reference to Exhibits K and L, as appropriate):

(continue on separate sheet, if necessary)

4. Lands of the United States affected (shown on Exhibit K)

	(Name)	(Acres)
a. National Forest	_____	_____
b. Indian Reservation	_____	_____
c. Public Lands Under Jurisdiction of	_____	_____
d. Other	_____	_____
e. Total U.S. Lands		_____

f. Check appropriate box:

/___/ Surveyed /___/ Unsurveyed land in public-land state:

(1) If surveyed land in public-land state provide the following:

Sections and subdivisions: _____

Range _____ Township: _____

Principal base and meridian: _____

(2) If unsurveyed or not in public-land state, see Item 8 of instructions: _____

5. Purposes of project (use of power output, etc.)

6. Construction of the project is planned to start _____ it will be completed within ____months from the date of issuance of license.
7. List here and attach copies of State water permits or other permits obtained authorizing the use or diversion of water, or authorizing (check appropriate box):
   /___/ the construction, operation, and maintenance
   /___/ the operation and maintenance
   of the proposed project.
8. Attach an environmental report prepared in accordance with the requirements set forth in the Instructions for Completing Application for Short-Form License (Minor), below.
9. Attach Exhibits K and L drawings.
10. State of _____
    County of _____ss:

_____
_____
_____,

being duly sworn, depose(s) and say(s) that the contents of this application are true to the best of _____knowledge or belief and that (check appropriate box)

/___/ _____ is (are) a citizen(s) of the United States
/___/ all members of the association are citizens of the United States
/___/ _____ is (are) the duly appointed agent(s) of the state (municipality)(corporation) (association)

and has (have) signed this application this ___ day of _____, 19___.

_____
(Applicant(s))

By _____

Subscribed and sworn to before me, a Notary Public of the State of _____, this ___ day of _____,

/SEAL/

_____

(Notary Public)

INSTRUCTIONS FOR COMPLETING APPLICATION FOR SHORT-FORM LICENSE (MINOR)

GENERAL

1. This application may be used if the proposed or existing project will have or has a total generating capacity of not more than 1,500 kW (2,000 horsepower). Advice regarding the proper procedure for filing should be requested from the Federal Energy Regulatory Commission in Washington, D. C.; or from one of the Commission's Regional Offices in Atlanta, Chicago, Fort Worth, New York, or San Francisco.

2. This application is to be completed and filed in an original and nine copies with the Federal Energy Regulatory Commission, 825 N. Capitol Street, N.E., Washington, D. C. 20426. Each of the original and the nine copies of the application is to be accompanied by:

a. One copy each of Exhibits K and L described below.

b. One copy each of a state water quality certificate pursuant to Section 401 of the Federal Water Pollution Control Act (or evidence that this certificate is not needed), and any water rights certificate or similar evidence required by state law relating to use or diversion of water. In lieu of submitting a copy of a Section 401 certificate (or other certificate), evidence that applications for these certificates have been filed with appropriate agencies, or that such certificates are not necessary, will be adequate to begin FERC processing of the application.

c. One copy each of any other state approvals necessary. (Applicant should contact the state natural resources department or equivalent to ascertain whether any such approvals are necessary.)

d. One copy of Applicant's environmental report, described below.

3. Applicant is required to consult with appropriate Federal, State, and local resources agencies during the preparation of the application and provide interested agencies with the opportunity to comment on the proposal prior to its filing with the Commission. The comments of such agencies must be attached to the application when filed. A list of agencies to be consulted can be obtained from the Commission's main office or the appropriate regional office.

4. No work may be started on the project until receipt of a signed license from the Commission. The application itself does not authorize entry upon Federal land for any purpose. If the project is located in part or in whole upon Federal land, the Applicant should contact the appropriate land management agency regarding the need to obtain a right-of-way permit. As noted above, other state or Federal permits may be required.

5. An applicant must be: a citizen or association of citizens of the United States; a corporation organized under the laws of the United States or a State; a State; or a municipality.

(a) If the applicant is a natural person, include an affidavit of United States citizenship.

(b) If the applicant is an association, include one verified copy of its articles of association. If there are no articles of association, that fact shall be stated over the signature of each member of the association. Also include a complete list of members and a statement of the citizenship of each in an affidavit by one of them.

(c) If the applicant is a corporation, include one copy of the charter or certificate and articles of incorporation, with all the amendments, duly certified by the secretary of state of the State where organized, and one copy of the by-laws. If the project is located in a state other than that in which the corporation is organized, include a certificate from the secretary of state of the State in which the project is located showing compliance with the laws relating to foreign corporations.

(d) If the applicant is a state, include a copy of the laws under the authority of which the application is made.

(e) If the applicant is a municipality as defined in the Federal Power Act, include one copy of its charter or other organization papers, duly certified by the secretary of state of the State in which it is located, or other proper authority. Also include a copy of the State laws authorizing the operations contemplated by the application.

Include a copy of all minutes, resolutions of stockholders or directors, or other representatives of the applicant, properly attested, authorizing the filing of the application. This information can be provided by a letter attached to the application.

6. If the stream or water body is unnamed, give the name of the nearest named stream or water body to which it is tributary.

7. The project description (application item 3) shall include, as appropriate: the number of generating units, including auxiliary units, the capacity of each unit, and provisions, if any, for future units; type of hydraulic turbine(s); a description of how the plant is to be operated, manual or automatic, and whether the plant is to be used for peaking; estimated average annual generation in kilowatt-hours or mechanical energy equivalent; estimated average head on the plant; reservoir surface area in acres and, if known, the net and gross storage capacity; estimated hydraulic capacity of the plant (flow through the plant) in cubic feet per second; estimated average flow of the stream or water body at the plant or point of diversion; sizes, capacities, and construction materials, as appropriate, of pipelines, ditches, flumes, canals, intake facilities, powerhouses, dams, transmission lines, etc.; and estimated cost of the project.

8. In the case of unsurveyed public land, or land not in a public-lands state, give the best legal description available. Include the distance and general direction from the nearest city or town, fixed monument, physical features, etc.

9. Exhibits K and L shall be submitted on separate drawings. Drawings for Exhibits K and L shall have identifying title blocks and bear the following certification: "This drawing is a part of the application for license made by the undersigned this ____ day of _____, 19____.

"

_____

(Name of Applicant)

10. The Commission reserves the right to require additional information, or another filing procedure, if data provided indicate such action to be appropriate.

EXHIBIT K-PROJECT LANDS AND BOUNDARIES

1. The Exhibit K is a planimetric map showing the portion of the stream developed, the location of all project works, and other important features, such as: the dam or diversion structure, reservoir pipeline, powerplant, access roads, transmission lines, project boundary, private land ownerships (clearly differentiate between fee ownership and land over which applicant only owns an easement), and Federal land boundaries and identifications.

2. The map shall be an ink drawing or drawing of similar quality on a sheet not smaller than 8 inches by 10-1/2 inches, drawn to a scale no smaller than one inch equals 1,000 feet. Ten legible prints shall be sumbitted with the application. Upon request after review of the application, the tracing must be submitted.

3. The project boundary shall be drawn on the map so that the relationship of each project facility and reservoir to other property lines can be determined. The boundary shall enclose all project works, such as the dam, reservoir, pipelines, roads, powerhouse, and transmission lines. The boundary shall be set at the minimum feasible distance from project works necessary to allow operation and maintenance of the project and control of the shoreline and reservoir. The distance in feet from each principle facility to the boundary shall be shown. The project boundary should be a surveyed line with stated courses and distances. A tape-compass survey is acceptable. True north shall be indicated on the map.

The area of Federal land in acres within the project boundary shall be shown. The appropriate Federal agency should be contacted for assistance in determining the Federal land acreage. For clarity, use inset sketches to a larger scale than that used for the overall map to show relationships of project works, natural features, and property lines.

4. Show one or more ties by distance and bearing from a definite, identifiable point or points on project works or the project boundary to established corners of the public land survey or other survey monuments, if available.

5. If the project affects unsurveyed Federal lands, the protraction of township and section lines shall be shown. Such protractions, whenever available, shall be those recognized by the agency of the United States having jurisdiction over the lands. On unsurveyed lands, show ties by distance and bearing to fixed recognizable objects.

6. If the project uses both Federal and private lands, the detailed survey descriptions discussed above for the project boundary apply only to Federal lands. General location data and an approximate project boundary will normally suffice for project works on private lands.

EXHIBIT L-PROJECT STRUCTURES AND EQUIPMENT

1. The exhibit shall be a simple ink drawing or drawing of similar quality on a sheet no smaller than 8 inches by 10-1/2 inches, drawn to a scale no smaller than one inch equals 50 feet for plans and profiles, and one inch equals 10 feet for sections. Ten legible prints shall be submitted with the application. Upon request after initial review of the application, tracings must be submitted.

2. The drawing shall show a plan, elevation, and section of the diversion structure and powerplant. Generating and auxiliary equipment proposed should be clearly and simply depicted and described. Include a north arrow on the plan view.

ENVIRONMENTAL REPORT

The environmental report should be consistent with the scope of the project and the environmental impacts of the proposed action; e.g., authorization to operate and maintain an existing project, or a project using an existing dam or other facility, would require less detailed information than authorization to construct a new project. The environmental report shall set forth in a clear and concise manner:

(1) A brief description of the project and the mode of operation, i.e., run-of-river, peaking or other specific mode.

(2) A description of the environmental setting in and near the project area, to include vegetative cover, fish and wildlife resources, water quality and quantity, land and water uses, recreational use, socio-economic aspects, historical and archeological resources, and visual resources. Special attention shall be provided endangered and threatened plant and animal species, critical habitats, and sites eligible for or included on the National Register of Historic Places. Assistance in the preparation of this information may be obtained from state natural resources departments and from local offices of Federal natural resources agencies.

(3) A description of the expected environmental impacts resulting from the continued operation of an existing project, or from the construction and operation of a new project or a project using an existing dam or other existing facility. Include a discussion of specific measures proposed by the Applicant and others to protect and enhance environmental resources and to mitigate adverse impacts of the project on the environmental resources and values, the cost of those measures, and the party undertaking to implement those measures if other than the Applicant.

(4) A description of alternative means of obtaining an amount of power equivalent to that provided by the project in the event that construction or continued operation of the project is not authorized.

(5) A description of the steps taken by the Applicant in consulting with Federal, state, and local agencies during the preparation of the environmental report. Indicate which agencies have received the final report and provide copies of letters containing the comments of those agencies.

APPENDIX A

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

SHORT-FORM LICENSE (MINOR)

Before Commissioners:

/Applicant/) Project No. _____

ORDER ISSUING SHORT-FORM LICENSE
( )

An application was filed on _____ and supplemented on _____by _____ _____ for a short-form license (minor) for a water power project.

/discussion, if any/

Issuance of a license for the project is in the public interest and in conformance with all applicable provisions of the Federal Power Act.

The Commission orders:

(A) This license is issued to _____ _____(Licensee) of _____, for a period effective the first day of the month in which this order is issued, and terminating _____ for /"construction, operation, and maintenance" or "operation and maintenance", as suitable/ of Project No. _____ located on _____, /a tributary of the _____,/ subject to the terms and conditions of the Federal Power Act, insofar as not expressly waived here, which Act is incorporated by reference as part of this license, and subject to such rules and regulations as the Commission issues or prescribes under the provisions of the Act.

RM78-9

(B) This project consists of:

(i) All lands constituting the project area and enclosed by the project boundary, to the extent of the Licensee's interests in those lands. The project area and the project boundary are shown and described by certain Exhibit K drawing(s), FERC No(s). _____, which also form part of the application for license.

(ii) Project works consisting of: /works listed/ The location, nature, and character of these project works are more specifically shown and described by the exhibit cited above and by Exhibit L drawing(s), FERC No(s). _____, which also form part of the application for license.

(iii) All of the structures, fixtures, equipment, or facilities used or useful in the maintenance and operation of the project and located in the project area, and any other property used or useful in connection with the project or any part of it; together with all riparian or other rights, the use or possession of which is necessary or appropriate in the maintenance or operation of the project.

The exhibits designated and described above in this paragraph (B) are approved and made a part of the license.

(C) Pursuant to Section 10(i) of the Federal Power Act, it is in the public interest to waive the following Sections of Part I of the Act, and they are excluded from the license:

4(b), except the second sentence relating to free access by the Commission or its agents to the project works and project records; 4(e), insofar as it relates to approval of plans by the Chief of Engineers and the Secretary of the Army; 10(c), insofar as it

Docket No. RM78-9

relates to depreciation reserves; 10(d); 10(f); 11; 12; 14, except insofar as the power of condemnation is reserved; 15; 16; 18, except as it relates to fishways; 19, 20; 21; 22; and 23(a), insofar as it relates to the determination of fair value.

(D) This license is also subject to the terms and conditions designated Articles 1 through _____ in Form L- ___, entitled _____, attached to and made a part of this license. This license is also subject to these additional special terms and conditions:

/any special articles/

(E) This order shall become final 30 days from the date of its issuance unless an application for rehearing shall be filed as provided in Section 313(a) of the Federal Power Act, and failure to file such an application shall constitute acceptance of this license. The acknowledgement of acceptance attached to this license shall be signed for the Licensee and returned to the Commission within 60 days from the date of issuance of this order.

By the Commission.

(S E A L)

Secretary

Docket No. RM78-9

IN TESTIMONY of (its) acknowledgement of acceptance of all of the terms and conditions of the foregoing order, _____ (Name), this ____ day of _____, 19__, has caused his (its corporate) name to be signed hereto (by _____ _____ its President, and its corporate seal to be affixed hereto and attested by _____, its _____ Secretary, pursuant to a resolution of its Board of Directors duly adopted on the _____ day of _____, 19__, a certified copy of the record of which is attached hereto).

_____

(By _____)

(Attest:

_____
Secretary)

Note:

Execute in quadruplicate. Statements within brackets apply only to corporations, municipalities and associations of citizens.

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D. C. 20426
EQUAL OPPORTUNITY EMPLOYER

POSTAGE AND FEES PAID
FEDERAL ENERGY REGULATORY COMMISSION
FERC 22
FIRST CLASS MAIL

APPENDIX III

To Section 6: LEGAL AND REGULATORY FEASIBILITY

SAMPLES OF EXEMPTION APPLICATIONS

OEPR DLF
E-9555

The Metropolitan Water District of Southern California

NOV 21 10 19 AM '78
FEDERAL ENERGY
REGULATORY
COMMISSION

Office of the General Manager

November 16, 1978

RECEIVED
DEC 26 1978
DIVISION OF LICENSED PROJECTS

Secretary
Federal Energy Regulatory Commission
825 North Capitol Street
Washington, D. C. 20426

Dear Sir:

Licensing Exemptions Request

The Metropolitan Water District of Southern California (hereinafter referred to as "Metropolitan") is a municipality within the meaning of the Federal Power Act. It is incorporated pursuant to the Metropolitan Water District Act originally enacted by the California Legislature in 1927 and reenacted in 1969 (California Stats. 1969, Chapter 209, as amended). It functions as a supplier of supplemental water pumped from the Colorado River and the Sacramento-San Joaquin Delta which it wholesales through a major water distribution system to 27 member public agencies throughout Southern California. It has recently become feasible to install hydroelectric power plants on Metropolitan's water distribution pipelines.

As you are aware, HR 4018 passed by Congress has recently been signed by the President. Section 213 of this legislation amends the Federal Power Act by adding Section 30 providing authority for the Commission to grant exemptions from the licensing requirements to:

> ". . . any facility (not including any dam or other impoundment) constructed, operated, or maintained for the generation of electric power which the Commission determines, by rule or order
>
> "(1) is located on non-Federal lands, and
>
> "(2) utilizes for such generation only the hydroelectric potential of a manmade conduit, which is operated for the distribution of water for agricultural, municipal, or industrial consumption and not primarily for

the generation of electricity.

"(b) The Commission may not grant any exemption under subsection (a) to any facility the installed capacity of which exceeds 15 megawatts."

Metropolitan believes that certain hydroelectric plants it is planning to construct on its pipelines fall within the criteria of the statute and hereby makes application that exemptions be issued for those plants which are identified as:

1. Greg Avenue Power Plant

2. Lake Mathews Power Plant

3. San Dimas Power Plant

4. Yorba Linda Power Plant

5. Foothill Feeder Power Plant

The plant locations are shown on Exhibit A, attacned hereto.

The facts justifying the exemptions are as follows:

1. Type of facility

The exemptions are sought only for facilities other than dams and other impoundments. The proposed facilities will perform the same function as existing pressure-control facilities on Metropolitan's pipeline system, except that electrical energy will be produced. (See: Exhibit A.)

2. Locations

The facilities will be located on non-Federal lands. The lands used are either owned by Metropolitan or an easement for their use was obtained. The boundaries of the land are shown on the aerial photo site plans included as Exhibit B.

3. Hydroelectric potential from water distribution system

The plants will utilize for generation only the hydroelectric potential of manmade conduits operated for the distribution of water for agricultural, municipal, or industrial consumption and will not be operated primarily for the generation of electricity.

Metropolitan is authorized under Sections 130(c) and 132 of its incorporating act to sell water at wholesale for municipal, industrial and agricultural purposes. It exercises this authority by distributing water for the authorized purposes through the pipeline system shown on Exhibit A. The plants will be located at various points on the pipelines of the water distribution system. Installing the facilities allows Metropolitan to use the flow pressure in its pipelines to produce energy instead of dissipating it as is done presently. They could not be operated principally for the generation of electricity because they only permit partial recovery of the large amounts of energy used to pump the water into Metropolitan's distribution system. (See: Exhibits F and G titled Hydraulic Profile Colorado River Aqueduct and Hydraulic Profile California Aqueduct respectively.)

4. Plant capacity

The plants will have installed capacities of less than 15 megawatts. Page 1 of Exhibit C shows the current estimated rated capacities of the proposed plants. Page 1 and the other pages of Exhibit C provide additional information on the power generation by the proposed plants.

In addition to the above criteria for exemption, Section 213 requires the Commission to consult with the United States Fish and Wildlife Service and the state agency having administration over the fish and wildlife resources of the state in which the facility is or will be located. To assist the Commission in these consultations Metropolitan has attached, as Exhibits D and E, letters from both the Fish and Wildlife Service and the Department of Fish and Game of the California State Resources Agency indicating both agencies' findings that there will be no significant adverse impact upon fish and wildlife resources and their habitats by the hydroelectric plants.

Please note that these facilities are the subject of a pending Commission proceeding in Docket No. E-9555. This application should not be regarded as affecting in any way Metropolitan's position and rights in that proceeding.

Very truly yours,

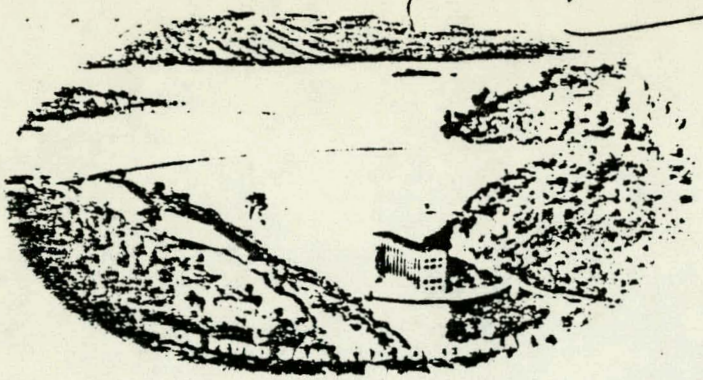
Evan L. Griffith
General Manager

JO:mj
Enclosures: 14 copies

P-2811 Comes

W. F. Koppler (Coop Applic

SF-FERC



TURLOCK IRRIGATION DISTRICT

NEBLETT
KOPPLER
BARBER

STANISLAUS AND MERCED COUNTIES, CALIFORNIA
P. O. BOX 949
333 EAST CANAL DRIVE
TURLOCK, CALIFORNIA 95380

September 20, 1978

Application filed in LP

Mr. Kenneth F. Plumb, Secretary
Federal Energy Regulatory Commission
825 N. Capital Street, N.E.
Washington, D.C. 20426

Re: Application for Major License
Drop No. 1 Power Plant

Dear Mr. Plumb:

Enclosed please find the original and nine conformed copies of an application for license to authorize the construction, operation, and maintenance of Turlock Irrigation District's proposed 3,000 KW Drop No. 1 Power Plant.

It is the District's understanding that one of the first steps in the Commission's evaluation of a proposed project is to determine if the project comes within the Commission's jurisdiction. The District feels that the Commission does not have jurisdiction over the proposed project but is submitting this application instead of a Declaration of Intent in order to help expedite the process in the event the Commission determines that it does have jurisdictio

The District would point out that the proposed project:

(1) Does not occupy in whole, or in part, lands of the United States;

(2) Is not located on navigable waters of the United States;

(3) Does not utilize surplus water or water power from a government dam; and

(4) Does not affect the interests of interstate commerce.

The proposed project will be located near the existing outlet structure/dam to Turlock Lake on land which will be owned solely by the District. Turlock Lake is located in the eastern portion of Stanislaus County, California. The Lake is an off-stream re-regulat reservoir of 48,740 acre-feet capacity which was constructed in 1913

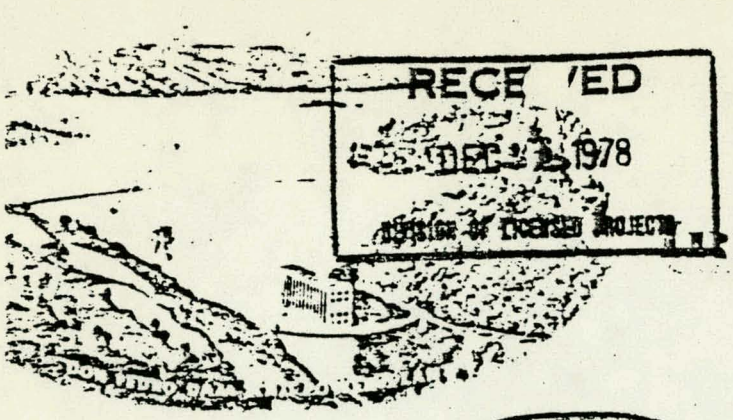
Irrigation water from Tuolumne River (which carries no commerce) is diverted by the District at La Grange Dam into a seven mile long canal to the Lake. Water from the Lake is proposed to be released through the proposed Drop No. 1 Power Plant to the District's main irrigation canal. The diversion canal and the main irrigation canal system were built in the 1890's. The irrigation water which passes through the existing Turlock Lake outlet structure/dam is almost entirely utilized by District irrigators. No commerce is carried on District's canal system. The proposed project will not change the District's current operations with regard to diversion at LaGrange Dam and storage and release of water from Turlock Lake other than to stabilize the level of Turlock Lake at a more constant elevation during the irrigation season (March 15 to October 15 of each year) in order to produce a constant maximum head on the power plant.

Unlike the 350,000 KW peaking power project in FPC vs Union Electric Company, 381 U.S. 90, 85 S. Ct. 1253 (1965), no surplus energy will be generated and no energy will be transmitted in inter-state commerce. The proposed 3,000 KW Drop No. 1 Power Plant will be tied into the District's existing twelve kilovolt distribution grid system and all power generated from the plant will be distribut to the District's electrical customers within its existing intra-State electrical service area.

Very truly yours,

ERNEST GEDDES
General Manager

RKM:rp
Encl.



TURLOCK
IRRIGATION DISTRICT
STANISLAUS AND MERCED COUNTIES, CALIFORNIA
P. O. BOX 949
333 EAST CANAL DRIVE
TURLOCK, CALIFORNIA 95380

November 28, 1978

Mr. Kenneth F. Plumb, Secretary
Federal Energy Regulatory Commission
825 N. Capital Street, N.E.
Washington, D.C. 20426

Re: Request for Exemption under Sec. 30 of Federal Power Act of Turlock Irrigation District's Drop No. 9 Power Plant

Dear Mr. Plumb:

The Turlock Irrigation District respectfully requests that the Federal Energy Regulatory Commission grant an exemption to the District from all Federal Power Act licensing requirements which might otherwise apply to the District's Drop No. 9 Power Plant on the ground that the facility is a conduit hydroelectric facility under the new Section 30 of the Federal Power Act.

In support of its request for exemption, the District would point out:

(1) The facility will be located on non-Federal lands.

(2) The facility will utilize for the generation of electrical power only the hydroelectric potential of a manmade conduit (i.e., the District's main irrigation canal), which is operated for the distribution of water for agricultural consumption and not primarily for the generation of electricity.

(3) The District has already consulted with the California Department of Fish and Game, the State agency exercising administration over the fish and wildlife resources of the State of California, and has received a favorable written comment on the facility. A copy of the Department's comment is enclosed and may also be found in Appendix A to the environmental report included in the short-form minor license application for the facility.

(4) A copy of the short-form minor license application has been submitted to the U.S. Fish and Wildlife Service for the Service's information and comment. A copy of the District's transmittal letter is enclosed for your information.

Please contact me if there is any additional information the Commission needs in considering this request for exemption.

Very truly yours,

TURLOCK IRRIGATION DISTRICT

Ernest Geddes
General Manager

Enclosures

by such person. Such compensation may be paid only if the Commission determines that—

"(A) the proceeding is significant, and

"(B) such person's intervention or participation in such proceeding without receipt of compensation constitutes a significant financial hardship to him.

"(3) Nothing in this subsection affects or restricts any rights of any intervenor or participant under any other applicable law or rule of law.

"(4) There are authorized to be appropriated to the Secretary of Energy to be used by the Office for purposes of compensation of persons under the provisions of this subsection not to exceed $500,000 for the fiscal year 1978, not to exceed $2,000,000 for the fiscal year 1979, not to exceed $2,200,000 for the fiscal year 1980, and not to exceed $2,400,000 for the fiscal year 1981.".

SEC. 213. CONDUIT HYDROELECTRIC FACILITIES.

Part I of the Federal Power Act is amended by adding the following new section at the end thereof:

"SEC. 30. (a) Except as provided in subsection (b) or (c), the Commission may grant an exemption in whole or in part from the requirements of this part, including any license requirements contained in this part, to any facility (not including any dam or other impoundment) constructed, operated, or maintained for the generation of electric power which the Commission determines, by rule or order—

"(1) is located on non-Federal lands, and

"(2) utilizes for such generation only the hydroelectric potential of a manmade conduit, which is operated for the distribution of water for agricultural, municipal, or industrial consumption and not primarily for the generation of electricity.

"(b) The Commission may not grant any exemption under subsection (a) to any facility the installed capacity of which exceeds 15 megawatts.

"(c) In making the determination under subsection (a) the Commission shall consult with the United States Fish and Wildlife Service and the State agency exercising administration over the fish and wildlife resources of the State in which the facility is or will be located, in the manner provided by the Fish and Wildlife Coordination Act (16 U.S.C. 661, et seq.), and shall include in any such exemption—

"(1) such terms and conditions as the Fish and Wildlife Service and the State agency each determine are appropriate to prevent loss of, or damage to, such resources and to otherwise carry out the purposes of such Act, and

"(2) such terms and conditions as the Commission deems appropriate to insure that such facility continues to comply with the provisions of this section and the terms and conditions included in any such exemption.

"(d) Any violation of a term or condition of any exemption granted under subsection (a) shall be treated as a violation of a rule or order of the Commission under this Act.".

SEC. 214. PRIOR ACTION; EFFECT ON OTHER AUTHORITIES.

(a) PRIOR ACTIONS.—No provision of this title or of any amendment made by this title shall apply to, or affect, any action taken by the Commission before the date of the enactment of this Act.

APPENDIX IV

To Section 6: LEGAL AND REGULATORY FEASIBILITY

PLANNING REGULATIONS

COMMONWEALTH OF PUERTO RICO
OFFICE OF THE GOVERNOR
PUERTO RICO PLANNING BOARD
SANTURCE, PUERTO RICO

PLANNING REGULATION NO. 2

RULES OF PROCEDURE FOR THE PRESENTATION OF PROJECTS FOR PUBLIC IMPROVEMENTS AND USE OF LANDS AND PUBLIC PROPERTIES

(Second Revision)

1959

COMMONWEALTH OF PUERTO RICO
Office of the Governor

San Juan, Puerto Rico August 21, 1959

Administrative
Bulletin
No. 528

PROCLAMATION OF THE GOVERNOR
OF THE COMMONWEALTH OF PUERTO RICO
PLANNING REGULATION NO. 2 (Second Revision)

Whereas, on August 12, 1959 pursuant to Act No. 213 of 1942, as amended, the Puerto Rico Planning Board adopted Planning Regulation No. 2 (Second Revision), in substitution of and as second revision of Planning Regulation No. 2 in force.

Therefore, I, Roberto Sánchez Vilella, Governor of the Commonwealth of Puerto Rico, in accordance with the provisions of Act No. 213 of 1942, do approve Planning Regulation No. 2, Second Revision, entitled Rules of Procedure for the Presentation of Projects for Public Improvements and Use of Lands and Public Properties, which shall become effective thirty (30) days after its approval. The Board shall give public notice of the amendments made to this Regulation by publishing, in one or more newspapers of island wide circulation in Puerto Rico, a general description of the provision that will mainly interest of affect the public.

In witness whereof, I have signed this proclamation and affixed hereto the Great Seal of the Commonwealth of Puerto Rico, in the City of San Juan, this 21st. day of August, 1959.

(Signed) ROBERTO SANCHES VILELLA
Acting Governor

(Seal)

Promulgated according to law this 21st. day of August, 1959.

I hereby certify that the above is a true and faithful copy of its original signed by the Governor.

(Signed) N. ALMIROTY
Assistant Secretary of State

Office of the Governor
PUERTO RICO PLANNING BOARD
Santurce, Puerto Rico

PLANNING REGULATION NO. 2
RULES OF PROCEDURE FOR THE PRESENTATION OF PROJECTS FOR PUBLIC IMPROVEMENTS AND USE OF LANDS AND PUBLIC PROPERTIES

(Second Revision)

TITLE I

GENERAL PROVISIONS

ARTICLE I.- Application.- Every improvement, acquisition, sale, transfer, exchange, lease or change in the use of lands or properties of the People of Puerto Rico shall be in accordance with the provisions of Planning Regulation No. 2 (Second Revision).

ARTICLE 2.- Definitions.- The following terms, whenever used in this Regulation, shall have the meaning given below:

(1) "public improvement" - shall include only permanent improvements, as for example, new construction, extensions and reconstructions (excluding repairs), but including also acquisition, sale, exchange, transfer, lease or change in the use of properties by state and municipal bodies.

(2) "Official" or "body" - shall include any office, bureau, department, board, commission, authority, administration, dependency, governmental, corporation or branch of the Commonwealth Government or any of its political subdivisions and its municipalities; including their agents, officials or employees.

ARTICLE 3.- Exemptions.- The provisions of this Regulation shall not apply to any public improvement or acquisition of properties authorized, paid, supervised, directed, undertaken and controlled exclusively

by the United States Government. In the case of public improvement whose location, character, and extent been are authorized in specific terms and for a definite location by law, the provisions of this Regulation shall only apply to those parts of the same which were not so specifically authorized.

ARTICLE 3 (a).- Local Planning Commissions.- The Board may refer to the corresponding Local Planning Commissions consultations on public improvement projects, pursuant to the provisions of Article 27 of Act 213 of 1942, as amended, and Planning Regulation Number 8 (Local Planning Regulation), whenever it deems necessary.

TITLE II

PROCEDURE FOR THE PRESENTATION OF CONSULTATIONS AND PROJECTS FOR PUBLIC IMPROVEMENTS

ARTICLE 4.- Filing of Consultations.- Every public improvement project shall first be filed whith the Board, as a consultation or preliminary project, accompanied by preliminary plans or sketches. No construction or site plans shall be made or caused to be made by any official or body without the Board having first authorized the preparation thereof, upon approval of the consultation; Provided, that the Board may exempt from the presentation of such consultation those cases in which it is considered unnecessary. Concerning these consultations, the following provisions shall govern.

(a) The favorable recommendation of the consultation by the Board does not imply the approval of the construction project, which shall be submitted for the study and consideration of the Board, in accordance with Act No. 213 of 1942, and the provisions of this Regulation.

(b) Before adopting municipal ordinance authorizing loans for the construction of public works, the municipal officials in conference with the Secretary of the Treasury of Puerto Rico or his representative, shall determine the financial capacity of the municipality to incur such debt. If the financial condition of the municipality is favorable for incurring such debt, municipal officials shall them obtain from the Board the preliminary approval of the proposed improvement to be constructed with the funds so secured, following the procedure for consultations established by the Board.

In some cases, this preliminary approval of the Board, may precede the conversations with the Secretary of the Treasury in regard to the financial capacity of the municipality to incur a debt.

Once the municipal officials have the preliminary approval of the Secretary of the Treasury and of the Board, they may draft, adopt and approve the corresponding ordinance which shall be submitted to the Governor for approval. If the Governor approve the ordinance, the mayor may submit to the Board, in final form, the specific projects for the construction of the proposed improvement.

ARTICLE 5.- Filing of Projects.- Any project which must be submitted to the Board in accordance with Section 22 of Act 213 of 1942, as amended, and in accordance with the provisions of this Regulation shall be submitted by the executive official or his authorized representative on Form No. 39 Revised (Planning Regulation No. 2), in original and two copies; said form to be provided by the Board. If the project involves the construction, reconstruction, or enlargement of a building or structure or a change in the use of lands or buildings, which require a build-

ing, sanitary, use or other permit, the sponsoring agency shall also submit to the Board the following additional documents; four (4) copies of Application Form NP-67-L; three (3) copies of the Construction Plans; one (1) copy of the Specifications; and one (1) copy of the Cost Estimates of the project. The project shall be presented in a clear and precise form, it shall be titled to indicate its scope and purpose, and shall include the following information, in triplicate:

(a) A statement setting forth the nature, purpose and extent of the project; its relationship to existing facilities, if any; and its coordination with any long-range program. Likewise, the advantages and benefits to be derived from such project shall be stated.

(b) Maps, site plans, topographic maps, construction plans and/or any other graphic information, which without considering minor details, shall clearly show the character, extent of the project and its location with respect to the neighborhood.

(c) In case the project involves any land subdivision, the sponsoring agency shall submit to the Board a description of the parcel to be subdivided and of the new lots to be formed, segregated for the purpose of sale, acquisition, transfer, exchange, etc., accompanied by a rough sketch showing the exact location and shapes of the lots to be created.

(d) Cost estimates of each project, including also cost estimates of successive annual improvements and extensions if the project is to be built by stages; and the source of the funds which shall be used to pay the cost of the project, its maintenance and operation, and/or its successive annual improvements and

extensions, as the case may be; Provided, that when the contract cost of the project exceeds the estimated cost reported to the Board by 30% or more, or whenever the source of funds change, in whole or in part, the sponsoring agency shall consult the Board before initiating the improvement to be done.

(e) Any other data which the corresponding official or body feels might be necessary or of assistance to the Board in considering such project, or that might help in comparing it with the Master Plan.

ARTICLE 6.- Additional Information.- The Board or its Chairman may request from the corresponding official or body, any additional information in addition to that required under Article 5, which may be considered necessary to clarify that already submitted, or to obtain further information; it being understood, that any project may be returned by the Board without considering it, because of insufficient information.

ARTICLE 7.- Request for Bids.- No request for bids shall be announced officially or unofficially, unless the proposed public improvements have been previously approved by the Board.

TITLE III

OFFICIAL ACTION OF THE BOARD

ARTICLE 8.- Term for taking Decision.- Any public improvement project submitted to the Board in accordance with the provisions of this Regulation and upon which no action has been taken within a period of sixty (60) days, shall be deemed approved, unless the submitting official or body consents to further delay; It being understood, that said term shall commerce from the date in which said projects is filed with the Secretary of the Board.

ARTICLE 9.- Term of Effectiveness of the Resolutions approved by the Board.- The approval by the Board of any project submitted in accordance with the provisions of this Regulation shall be in effect for a period of one (1) year, after the date of approval.

If the improvement has not been started on the date of expiration, the sponsoring agency shall submit the project to the Board, whenever it is ready to undertake the project; Provided, that this term may be extended if so requested by the submitting agency within thirty (30) days before the date of expiration; and Provided, that the Board considers that such extension is not detrimental to the public interest.

ARTICLE 10.- Amendments to the Master Plan.- If the favorable or unfavorable recommendations of the Board on any project submitted under this Regulation constitute a change or amendment to an adopted Master Plan, the Board shall hold a public hearing on the project and the specific amendment to the Master Plan. Such public hearing shall be called and notification given as provided in Planning Regulation No. 1 (Third Revision).

TITLE IV

RECONSIDERATIONS AND APPEALS

ARTICLE 11.- Petition for Reconsideration.- From any resolution or decision taken by the Board on a consultation or public improvement project submitted to it under this Regulation, a petition for reconsideration may be filed before the Board by the submitting agency, within a period of fifteen (15) days, after date of notification of said resolution or decision.

ARTICLE 12.- Appeals.- From any final resolution or decision taken by the Board in connection with any project submitted to it inder this

Regulation, an appeal may be filed within a term of twenty (20) days, after notice of said resolution or decision, before the Governor of Puerto Rico, who may amend, alter or annul the decision of the Board.

TITLE V

LEGAL PROVISIONS

ARTICLE 13.- Applicability of Terms.- Any word used in the singular in this Regulation in understood to include the plural also when such a use is justified, or vice versa; likewise, the masculine is understood to include the feminine, and the word person will include both the natural and legal persons, association, corporation, or any other body.

ARTICLE 14.- Saving Clause.- Any regulation or provision contrary or incompatible with this Regulation shall be null and void.

ARTICLE 15.- Effective Date.- Planning Regulation No. 2 (Second Revision), as well as any amendments thereto, adopted by the Board and approved by the Governor, shall become effective thirty (30) days after approval.

APPROVED: August 21, 1959

EFFECTIVE: September 21, 1959

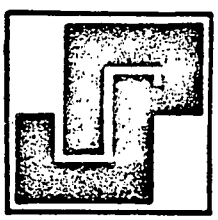
APPENDIX V

To Section 6: LEGAL AND REGULATORY FEASIBILITY

PROPOSED MODIFICATIONS
GOVERNING PROJECTS FOR PUBLIC IMPROVEMENTS

ESTADO LIBRE ASOCIADO DE PUERTO RICO
Oficina del Gobernador
JUNTA DE PLANIFICACION
Santurce, Puerto Rico

PROYECTO DE ENMIENDAS
AL
REGLAMENTO SOBRE MEJORAS PUBLICAS
(REGLAMENTO DE PLANIFICACION #2)



(Para Discusión en Vista Pública)

ENMIENDAS PROPUESTAS

AL

REGLAMENTO SOBRE MEJORAS PUBLICAS
(REGLAMENTO DE PLANIFICACION NUM. 2)

INTRODUCCION

Este documento contiene las enmiendas propuestas al Reglamento sobre Mejoras Públicas (Reglamento de Planificación Núm. 2). Dichas enmiendas conllevan el propósito básico de actualizar las disposiciones y de mejorar la organización del texto del referido reglamento.

Para mejorar la organización del texto se divide la materia en tópicos, secciones y subsecciones, cada subsección numerada en base a la sección principal; se aclara su contenido; se elimina lo innecesario; se armonizan sus requisitos; y se incorporan bajo un mismo tópico o sección todo lo relacionado con dicho tópico o sección.

La revisión propuesta del contenido incluye las siguientes modificaciones:

I. PREFACIO

A. Se incluye un prefacio para explicar las consideraciones que motivan la preparación del reglamento y los fines que se persiguen.

II. TABLA DE MATERIAS

A. Se incluye una tabla de materias para identificar la materia cubierta por el reglamento.

III. TOPICO 1 - APLICACION E INTERPRETACION

A. Se introducen nuevas disposiciones sobre título, autoridad, términos definidos, disposiciones de otros reglamentos, interpretación de reglamentos y salvedad, en armonía con las disposiciones de ley y con los otros reglamentos de planificación vigentes.

B. Se relaciona el título largo actual con un título corto, por el cual se conocerá el reglamento enmendado.

C. Se aclara el ámbito de la aplicación para incluir los funcionarios u organismos.

D. Se incorporan en este tópico disposiciones sobre fecha de vigencia del reglamento y términos empleados por entender que las mismas estaban fuera de lugar dentro del texto actual.

E. Se corrigen las definiciones y se añaden otras para simplificar la interpretación del reglamento.

IV. TOPICO 2 - MEJORAS PUBLICAS

A. Se establecen requisitos generales sobre conformidad con el reglamento y con planes o programas específicos para toda mejora pública a realizarse.

B. Se establecen requisitos generales sobre la presentación de la mejora pública y la preparación de planos de construcción.

C. Se elimina el requerimiento de obtener aprobación preliminar previo a la adopción de proyectos o anteproyectos de ordenanzas municipales autorizando empréstitos para construir obras públicas.

D. Se establecen requisitos generales sobre el anuncio de subasta pública para realizar mejoras públicas.

E. Se aclaran disposiciones relacionadas con la radicación de las consultas y se introducen disposiciones para establecer el alcance de su aprobación.

F. Se aclaran las disposiciones relacionadas con la radicación de los proyectos de construcción y se introducen disposiciones para establecer el alcance de sus aprobaciones.

V. TRAMITACION DE CONSULTAS Y PROYECTOS

A. Se introducen disposiciones para establecer que la tramitación de consultas y proyectos es una función de la Junta de Planificación, la cual podrá delegar la misma o parte de ella en la Administración de Reglamentos y Permisos, mediante el mecanismo que establece la ley.

B. Se introducen disposiciones para establecer la acción a tomarse por la Administración sobre funciones delegadas y las reglas que aplicarán en la toma de decisiones por ésta.

P R E F A C I O

La realización coordinada de mejoras públicas constituye uno de los factores que tienden a crear condiciones favorables para que la sociedad pueda desarrollarse integralmente. Siendo la Junta de Planificación de Puerto Rico el organismo encargado por ley de guiar el desarrollo integral de Puerto Rico, nada más lógico, que corresponda también a este organismo la facultad de reglamentar la realización de tales mejoras públicas.

A tenor con esta facultad la Junta de Planificación de Puerto Rico habrá de requerir la presentación de consultas y proyectos de construcción para toda mejora pública a emprenderse o a realizarse por cualquier funcionario u organismo del Estado Libre Asociado de Puerto Rico.

No obstante lo anterior, la Junta podrá, cuando lo estime conveniente para una mejor utilización de los recursos, dictaminar mediante resolución, cuáles mejoras públicas habrán de quedar exentas total o parcialmente de cumplir con tales presentaciones. Las normas que adopte la Junta al efecto contendrán aquellos criterios y condiciones que garanticen que tales mejoras públicas, al igual que las no exentas, habrán de ser conforme en su posición, naturaleza y extensión al Plan de Desarrollo Integral de Puerto Rico, a los Planes de Usos de Terrenos y al Programa de Inversiones de Cuatro Años.

La tramitación de las consultas y proyectos de construcción requeridos para la realización de mejoras públicas será una función de la Junta de Planificación de Puerto Rico, salvo cuando delegadas a la Administración

de Reglamentos y Permisos, mediante una resolución que cumpla con lo establecido en la Ley Número 75 del 24 de junio de 1975, enmendada.

Las determinaciones que tome la Administración de Reglamentos y Permisos en base a las delegaciones que le haga la Junta de Planificación de Puerto Rico deberán ser consistentes con las políticas, normas y reglamentos adoptados o aprobados por dicha Junta. Tales determinaciones se regirán por las disposiciones, incluyendo las que rigen los procesos apelativos, que les hubiesen sido aplicables de haber hecho dicha Junta la determinación o decisión.

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Y
PROYECTOS DE CONSTRUCCION

TOPICO I

APLICACION E INTERPRETACION

SECCION 1.00 - DISPOSICIONES GENERALES

1.01 - Título.- Este Reglamento de Planificación Número 2, para establecer las reglas de procedimiento para la presentación de consultas y proyectos de mejoras, adquisición, venta, permuta, cesión, arrendamiento o cambio en el uso de terrenos y propiedades del Gobierno del Estado Libre Asociado de Puerto Rico o de cualesquiera de sus organismos gubernamentales, se conocerá y citará como el "Reglamento Sobre Mejoras Públicas".

1.02 - Autoridad.- Este reglamento se adopta por la Junta de Planificación de Puerto Rico a virtud de las disposiciones de la Ley Núm. 75 del 24 de junio de 1975, enmendada.

1.03 - Aplicación.- Las disposiciones contenidas en este reglamento aplicarán y cubrirán a:

(1) - Toda mejora pública, según definidas en este reglamento. En el caso de mejoras públicas cuya posición, naturaleza y extensión hayan sido autorizadas en términos específicos y para ubicación definida por ley, la aplicación de este reglamento se circunscribirá a aquellas partes de las mismas que no estuvieren así especificadas.

(2) - Todo funcionario u organismo.

1.04 - Vigencia.- Este reglamento y las enmiendas que al mismo adopte la Junta de Planificación de Puerto Rico, regirán a los quince (15) días de su aprobación por el Gobernador.

1.05 - Términos Empleados.- Cuando así lo justifique su uso en este reglamento, se entenderá que toda palabra usada en singular incluye el plural y viceversa, y el masculino incluirá el femenino y viceversa.

1.06 - Términos Definidos.- Los vocablos que se definen en este reglamento, siempre que se empleen en su contenido y a todos los efectos del mismo, tendrán el significado que se expresa para cada término.

1.07 - Disposiciones de Otros Reglamentos.- Las disposiciones de este reglamento quedarán complementadas por las disposiciones de cualquier otro reglamento en vigor adoptado o aprobado por la Junta de Planificación de Puerto Rico.

1.08 - Interpretación de Reglamentos.- La Junta podrá, mediante resolución al efecto, aclarar e interpretar disposiciones de este reglamento y su relación con otros reglamentos en armonía con los fines y propósitos generales de los mismos y de la Ley Número 75 del 24 de junio de 1975, enmendada.

1.09 - Salvedad.- Si cualquier palabra, oración, inciso, subsección, sección, tópico u otra parte de este reglamento, fuera impugnada por cualquier razón ante un tribunal y declarada inconstitucional o nula, tal sentencia no afectará, menoscabará o invalidará las restantes disposiciones y partes de este reglamento, sino que su efecto se limitará a la palabra, oración, inciso, subsección, sección, tópico o parte específica así declarada inconstitucional o nula y la nulidad o invalidez de cualquier palabra, oración, inciso, subsección, sección, tópico o parte de algún caso específico no afectará o perjudicará en sentido alguno su aplicación o validez en cualquier otro caso.

TOPICO 2

DEFINICIONES

SECCION 2.00 - SIGNIFICADO DE TERMINOS

2.01 - Administración de Reglamentos y Permisos.- Organismo gubernamental creado por la Ley Número 76 del 24 de junio de 1975, enmendada, conocida como la "Ley Orgánica de la Administración de Reglamentos y Permisos".

2.02 - Administrador.- El Administrador de la Administración de Reglamentos y Permisos, o los funcionarios que lo substituyan o en quienes él pueda delegar sus poderes y atribuciones según dispuesto por Ley.

2.03 - Consulta.- Trámite preliminar iniciado por un funcionario u organismo para obtener la opinión, determinación o acuerdo de la Junta respecto a los méritos de una mejora pública.

2.04 - Funcionario u Organismo.- El Gobierno del Estado Libre Asociado de Puerto Rico o cualesquiera de sus partes, oficinas, negociados, departamentos, comisiones, dependencias, instrumentalidades, o corporaciones gubernamentales o municipios, sus agentes, funcionarios o empleados.

2.05 - Funcionario u Organismo Auspiciador.- Todo funcionario u organismo facultado para emprender mejoras públicas.

2.06 - Junta.- La Junta de Planificación de Puerto Rico como organismo

colegiado, inclusive cuando funcione dividida en Salas, conforme a lo dispuesto en la Ley Número 75 del 24 de junio de 1975, enmendada, conocida como "Ley Orgánica de la Junta de Planificación de Puerto Rico.

2.07 - Mejora Pública.- Toda mejora permanente; toda nueva construcción, ampliación o reconstrucción (sin incluir reparación) de obra pública autorizada, pagada, supervisada, dirigida, emprendida o controlada por algún organismo gubernamental, incluyendo, entre otras, toda adquisición, venta, permuta, cesión, arrendamiento o cambio en el uso de propiedades por cualquier funcionario u organismo y las llevadas a cabo mediante contratos de obra con entidades privadas.

2.08 - Obra Pública.- Edificios, estructuras incluyendo las mejoras y trabajos que se realicen en el terreno para facilitar o complementar la construcción de éstos, así como las mejoras e instalaciones necesarias para el uso, segregación, subdivisión o desarrollo de terrenos.

2.09 - Proyecto de Construcción.- Conjunto de documentos comprendiendo planos finales de mensura, de localización, y de construcción, incluyendo detalles, estimados de costos y especificaciones con suficiente precisión para permitir la realización de la mejora pública.

2.10 - Reglamentos de Planificación.- Los reglamentos aprobados o promulgados por la Junta de acuerdo con la autoridad que le confiere su "Ley Orgánica" o cualquiera otra ley.

2.11 - Resolución.- Todo informe o documento contentivo de un acuerdo o decisión adoptado por la Junta.

TOPICO 3

MEJORAS PUBLICAS

SECCION 3.00 - REQUISITOS GENERALES

3.01 - Conformidad con el Reglamento.- Toda mejora pública cumplirá en todos sus aspectos con lo establecido en este reglamento, a menos que se haga constar específicamente lo contrario.

3.02 - Conformidad con Planes o Programas Específicos.- Toda mejora permanente estará en armonía en su posición, naturaleza y extensión al Plan de Desarrollo Integral de Puerto Rico, a los Planes de Usos de Terrenos y al Programa de Inversiones de Cuatro Años, según adoptados por la Junta. La autorización para desarrollar cualquier mejora permanente que no esté contemplada dentro del Programa de Inversiones de Cuatro Años, es una discreción del Gobernador del Estado Libre Asociado de Puerto Rico.

3.03 - Presentación de la Mejora Pública.- Toda mejora pública deberá presentarse por el funcionario u organismo auspiciador, en primera instancia, en forma de consulta y luego en forma de proyecto de construcción, salvo cuando expresamente eximida de una o de ambas presentaciones mediante una resolución de la Junta.

3.04 - Preparación de Planos de Construcción.- No se harán o se ordenará que se hagan planos de construcción o de emplazamientos para mejora pública alguna, por ningún funcionario u

organismo auspiciador, sin antes haber sido autorizado su preparación mediante la aprobación de una consulta o permitida su preparación mediante una resolución de la Junta que exima tal mejora pública de la presentación de la consulta.

3.05 -Subastas Públicas.- Solamente se anunciarán para subasta pública aquellas mejoras públicas a realizarse que cumplan con lo establecido en este reglamento. El anuncio de subasta pública siempre incluirá el número de radicación que se le otorgue a la mejora pública en base a las radicaciones requeridas en este reglamento.

SECCION 4.00 - CONSULTAS REQUERIDAS

4.01 - Disposición General.- Se requerirá la presentación de una consulta para toda mejora pública que no haya sido expresamente eximida de tal presentación mediante una resolución de la Junta.

4.02 - Radicación de la Consulta.- Toda consulta requerida para cualquier mejora pública será radicada, para su consideración por la Junta, incluyendo una memoria explicativa describiendo la naturaleza y alcance del proyecto, costo aproximado y procedencia de fondos y acompañada del correspondiente croquis o plano preliminar y documentación fehaciente de que el proponente es titular del predio o está expresamente autorizado a desarrollar en el mismo,cuando se trate de terrenos de propiedad pública, o evidencia de que el proponente notificó al titular del predio cuando se trate de proyectos a ubicarse en terrenos privados. La misma será acompañada, además, de una certificación que indique haber cumplido con la Ley Número 9 del 18 de junio de 1970 (Ley sobre Política Pública Ambiental).

Toda persona notificada sobre la radicación de una consulta o proyecto de majora pública podrá someter a la Junta, con copia al funcionario u organismo auspiciador, sus puntos de vista dentro del término de diez (10) días contados a partir del recibo de la notificación. No obstante, la Junta podrá

tramitar la consulta o el proyecto de mejora pública correspondiente sin que haya transcurrido el referido término, cuando el interés público envuelto así lo justifique.

4.03 - Información Adicional.- El funcionario u organismo auspiciador someterá cualquier otra información o documento que le sea requerido para aclarar o ampliar la información o documentos ya sometidos.

4.04 - Aprobación de la Consulta.- La recomendación favorable de una consulta requerida no implica en forma alguna la aprobación del proyecto de transacción o de construcción en sí, el cual deberá regirse por lo establecido en la Sección 5.00 de este reglamento y en cualquier resolución de la Junta eximiendo de la presentación de tal proyecto de transacción o de construcción.

SECCION 5.00 - PROYECTOS DE CONSTRUCCION REQUERIDOS

5.01 - Disposición General.- Se requerirá la presentación de un proyecto de construcción para toda mejora pública que no haya sido expresamente eximida de tal presentación mediante una resolución de la Junta.

5.02 - Radicación del Proyecto.- Todo proyecto de construcción requerido para una mejora pública será radicado para su consideración por la Junta, excepto cuando delegada tal función a la Administración de Reglamentos y Permisos, en forma clara y precisa, designándolo con un título que indique los propósitos y alcances del mismo, y acompañado con la información o documentos que se mencionan a continuación:

(1) - Declaración exponiendo la naturaleza, propósitos y alcances del proyecto propuesto; su relación con facilidades ya existentes, si alguna; y su coordinación con el Programa de Inversiones de Cuatro Años.

(2) - Mapas, planos de situación, de mensura, de construcción o cualesquiera otros datos gráficos que, sin entrar en detalles, demuestren claramente la posición, naturaleza y extensión del proyecto, incluyendo su relación con respecto a la vecindad.

(3) - Descripción de la finca principal, cuando el proyecto requiera una lotificación o segregación de terrenos, y del predio o los predios a segregar, vender, adquirir,

ceder, permutar o arrendar, acompañada de un plano de mensura indicando la ubicación exacta y forma de los solares o predios a formarse y la localización de edificios o estructuras existentes, si los hubiere.

(4) - El costo aproximado de cada fase del proyecto, así como el costo aproximado de las mejoras y extensiones anuales sucesivas, si el proyecto fuese a construirse por etapas; la procedencia de los fondos para sufragar el costo del proyecto, su conservación y operación o sus mejoras y extensiones anuales sucesivas, según sea el caso.

(5) - Las especificaciones técnicas del proyecto.

(6) - Cualquier otra información que el funcionario u organismo auspiciador estime necesario para, o que en su opinión facilite la construcción del proyecto sometido.

5.03 - Información Adicional.- El funcionario u organismo auspiciador someterá cualquier otra información o documento que le sea requerido para aclarar o ampliar la información o documentos ya sometidos.

5.04 - Exenciones.- No será necesario someter planos de construcción cuando el funcionario u organismo auspiciador haya sido expresamente eximido de cumplir con este requerimiento mediante una resolución de la Junta. No obstante, dicho

funcionario u organismo auspiciador cumplirá con todas las condiciones que le fueran impuesta en dicha resolución.

5.05 - Aprobación del Proyecto de Construcción.- La recomendación favorable de un proyecto de construcción no implica en forma alguna la autorización para el comienzo de la construcción de las obras a menos que se haya cubierto cualquier otro trámite de ley o reglamento aplicable.

Cuando, por alguna razón, cambie total o parcialmente la procedencia de los fondos a utilizarse para dicho proyecto, el funcionario u organismo auspiciador deberá informar a la Junta al respecto antes de dar comienzo a las obras.

5.06 - Permiso de Construcción.- Todo proyecto de construcción, ampliación o reconstrucción de algún edificio o estructura, que en base a las leyes y reglamentos aplicables, requiera un permiso de construcción, será tramitado de conformidad con lo establecido en el Reglamento para la Certificación de Proyectos de Construcción.

TOPICO 4

TRAMITACION DE CONSULTAS

Y

PROYECTOS DE CONSTRUCCION

SECCION 6.00 - ACCION POR LA JUNTA

6.01 - Disposición General.- La Junta estudiará, tramitará y resolverá las consultas y proyectos de construcción requeridos para mejoras públicas, que sean sometidos bajo las disposiciones de este reglamento. Cuando la Junta lo estime necesario se celebrarán vistas públicas con notificación a las partes.

6.02 - Asesoramiento.- La Junta, cuando lo considere necesario, consultará cualquier Comisión Local o Regional de Planificación, respecto a cualquier consulta o proyecto de construcción para una mejora pública, en su municipio o región.

6.03 - Término que tiene la Junta para Actuar.- Tras la radicación del proyecto de construcción para una mejora pública, la Junta deberá emitir su decisión dentro de un plazo de sesenta (60) días. Todo proyecto de construcción que no se desaprobare dentro de dicho plazo, se considerará aprobado, a menos que el funcionario u organismo auspiciador dé su consentimiento para una tardanza mayor.

6.04 - Término de Vigencia de las Decisiones Favorables.- La recomendación favorable de cualquier consulta o proyecto de construcción requeridos para una mejora pública, que se emita bajo las disposiciones de este reglamento, estará vigente por un período de dos (2) años, a partir de la fecha en que se haya notificado la decisión de la Junta. Este término podrá prorrogarse a petición del funcionario u organismo auspiciador, cuando no se considere tal extensión contraria al interés público, y siempre que la petición de prórroga se someta con por lo menos treinta (30) días de antelación a la fecha de expiración de la decisión, señalándose los motivos en que se basa la petición.

Transcurrido el término de vigencia establecido sin que se haya solicitado una prórroga para extender la vigencia de la decisión, ésta quedará sin efecto o valor alguno para todos los efectos legales.

6.05 - Notificación de las Decisiones Favorables.- La Oficina del Secretario de la Junta notificará al dueño de la propiedad particular, que será afectada por la aprobación de una consulta o proyecto de mejora pública y a cualquier otra persona, que sea parte interesada, cuyo nombre y dirección obren en el expediente del caso, mediante el envío de copia certificada de la resolución o decisión adoptada por dicho organismo.

6.06 - Reconsideración de las Decisiones.- La Junta podrá entender en cualquier petición de reconsideración relacionada con una decisión sobre una consulta o proyecto de construcción de una mejora pública, emitida bajo las disposiciones de este reglamento, cuando ésta se someta a su consideración por el funcionario u organismo auspiciador dentro de un término de veinte (20) días, a partir de la fecha de notificación de la decisión.

6.07 - Revisión de las Decisiones.- La función de revisar en apelación las decisiones de la Junta es una facultad que le concede la ley al Gobernador del Estado Libre Asociado de Puerto Rico, sujeta a que se solicite tal revisión por el funcionario u organismo auspiciador, dentro de un plazo de veinte (20) días a partir de la fecha de notificación de la decisión. El Gobernador está asimismo facultado para sostener, enmendar, alterar o revocar dicha decisión.

6.08 - Prerrogativas de la Junta.- La Junta podrá delegar en la Administración de Reglamentos y Permisos la implantación de las disposiciones de este reglamento mediante una resolución que cumpla con lo establecido en la Ley Número 75 del 24 de junio de 1975.

La Junta podrá además, según lo crea conveniente para el mejor aprovechamiento de los recursos, adoptar normas que

indiquen los criterios que se utilizarán en la determinación de los tipos de mejoras públicas a eximirse de cumplir total o parcialmente con lo dispuesto en este reglamento. Tales normas, cuando se trate de mejoras públicas municipales, considerarán entre otros, los siguientes criterios: el costo, la magnitud o el tamaño de la mejora pública, y el impacto de la misma.

SECCION 7.00 - ACCION POR LA ADMINISTRACION

7.01 - Disposición General.- Las consultas y proyectos de construcción requeridos para mejoras públicas, que le sean delegados por la Junta a la Administración de Reglamentos y Permisos se estudiarán, tramitarán y resolverán de conformidad con las disposiciones de este Reglamento.

7.02 - Determinaciones Sobre Delegaciones.- Las determinaciones que la Administración de Reglamentos y Permisos tome a base de las delegaciones que le haga la Junta deberán ser consistentes con las políticas, normas y reglamentos adoptados o aprobados por la Junta. Tales determinaciones se regirán por las disposiciones, incluyendo las que rijan los procesos apelativos, que les hubiesen sido aplicables de haber hecho la Junta de determinación o decisión que corresponda y, asimismo, por las que rigen a dicha Administración de Reglamentos y Permisos en lo que fueren compatibles.

CERTIFICO: Que el presente Reglamento de Planificación Número 2 (Reglamento Sobre Mejoras Públicas) fue adoptado por la Junta de Planificación de Puerto Rico en su reunión del de de 1978, como parte integral de la Resolución Número RP-2-0-78, y para su conocimiento y uso general expido la presente bajo mi firma y sello de la Junta en San Juan, Puerto Rico, a

TERESA BIAGGI LUGO
Secretaria

APPENDIX VI

To Section 6: LEGAL AND REGULATORY FEASIBILITY

PUERTO RICO PLANNING BOARD APPLICATION

JUNTA DE PLANIFICACION
Negociado de Consultas
División Técnica de Revisión Ambiental

JP-224 REV.
Feb. 77

FORMULARIO PARA EVALUACION AMBIENTAL

INSTRUCCIONES GENERALES:

a. Este formulario debe ser cumplimentado en todas sus partes. Donde no se aplique se indicará N/A (no aplica).

b. De considerarse que la información contenida en este formulario no es suficiente, acompañe memoria descriptiva del proyecto.

c. Someta plano de ubicación a escala 1:20,000 y plano mostrando la propuesta contemplada a escala conveniente que incluyan los siguientes datos:

   1. Area y colindancias del predio o finca

   2. Cuerpos de agua, desagues naturales, terrenos pantanosos, sistemas naturales, topografía con curvas de nivel a intervalo de uno (1) o cinco (5) metros, servidumbres, etc.

d. Indique tipo de financiamiento:

   ( ) Convencional ( ) Federal ( ) Estatal

   Si es federal o estatal especifique programa o título: _____

   _____

e. Someta igual número de copias (formulario, planos, endosos) en base a la siguiente tabla:

3 copias	8 copias
*A. Residencial - Hasta 450 unidades de vivienda	A. Residencial - sobre 450 unidades de vivienda
*B. Comercial - usos conformes en Distritos C-1, C-2, C-3	B. Comercial - uso conformes en Distritos C-4, C-5, C-6
*C. Industrial - usos conformes en los distritos I-1 e I-L-1	C. Industrial - usos conformes en los Distritos I-2 e I-L-2
* a conectarse al sistema de A.A.A. y que esté fuera de áreas naturales críticas e inundables.	

NOTA: ESTA OFICINA SOLICITARA COPIAS ADICIONALES DE CUALQUIER DOCUMENTO CUANDO LO CONSIDERE NECESARIO

CERTIFICO: Que la información aqui expuesta es correcta y verdadera, según mi mejor saber y entender.

_____ _____
firma fecha

Caso Núm. _____ Sol. Núm. _____

Proponente _____

Dirección Postal _____

_____ Teléfono _____

Nombre del Proyecto _____

Dirección del Proyecto _____

Zonificación Vigente _____

Uso actual de los terrenos a desarrollarse _____

_____

Cabida de los terrenos cuyo desarrollo se propone (indique número de metros cuadrados y su equivalente en cuerdas) _____

_____

Número de ( ) solares a construirse _____
( ) viviendas a construirse _____
( ) apartamentos a construirse _____

Existe la posibilidad de que sea parte de un desarrollo mayor

_____ Si _____ No

En caso afirmativo indique el número de solares, viviendas y/o apartamentos del desarrollo _____

I. Proyecto

A. Area del proyecto

1. Descripción del lugar (incluya vegetación y fauna acuática y/o terrestre) _____

_____

_____

_____

_____

2. Topografía: _____ llana _____ semi-llana

_____ accidentada

_____ metros _____ metros
evaluación actual evaluación final

3. Característica geológica y/o calidad de los suelos

_____

_____

_____

4. Sumideros naturales _____ Si _____ No

Describa _____

_____

5. Industrias existentes en el área:

Nombre	Ubicación
_____	_____
_____	_____

6. Estructuras físicas en el área:

Nombre	Ubicación
_____	_____
_____	_____

7. Descripción de área circunvecina (uso, topografía, etc.)

_____

_____

II. Sistemas Naturales y Artificiales

Marque los sistemas naturales y artificiales existentes en el área del proyecto y área circunvecina. Si están fuera del proyecto indique la distancia.

A. Sistemas naturales

Sistema	Dentro	Fuera	Distancia en metros	Nombre bajo el cual se conoce el sistema
Manglar	( )	( )		
Area costanera, playa	( )	( )		
Sabana	( )	( )		
Estuario	( )	( )		
Bosque	( )	( )		
Refugio de Aves	( )	( )		
Arrecifes	( )	( )		
Dunas	( )	( )		
Pántano	( )	( )		
Río	( )	( )		
Unidad Agrícola	( )	( )		
Quebrada	( )	( )		
Manantial.....	( )	( )		
Lago	( )	( )		
Laguna	( )	( )		
Mogote	( )	( )		
Cantera	( )	( )		
Otros (especifique).....	( )	( )		
a. _____				
b. _____				

B. Sistemas artificiales

Sistema	Dentro	Fuera	Distancia en metros	Nombre bajo el cual se conoce el sistema
Lago artificial	( )	( )		
Canal	( )	( )		
Pozo	( )	( )		
Sistema de riego	( )	( )		
Represa	( )	( )		
Otros (especifique)	( )	( )		
a. _____				
b. _____				

III. Impacto sobre sistemas naturales

A. Ruidos

Indique clase y nivel de ruidos (dB) generados por el proyecto durante su construcción y operación.

_____

_____

_____

B. Movimiento de tierra

1. ¿Requerirá el proyecto movimiento de tierra? _____ Si _____ No

2. Si la contestación es sí, indique lo siguiente:

a) descripción del movimiento de tierra (incluyendo volumen aproximado)

_____

_____

b) posibles daños al ambiente

( ) deforestación ( ) polvo ( ) nivelación

( ) sedimentación ( ) erosión

c) medidas para reducir al mínimo los daños marcados en el apartado b anterior

_____

_____

d) tipo de equipo a usarse

e) descripción del área de disposición de la capa vegetal del terreno (top soil)

_____

_____

_____

C. Inundaciones

Dentro Fuera Frecuencia_____

Si ( ) ( ) Cota de elevación de las aguas_____

D. Dragados

1. Propósito _____

2. Método a usarse_____

_____

3. Extensión y profundidad del dragado _____

4. Localización y área del lugar de disposición del material dragado _____

E. Canalización

Indique si se propone la canalización de algún cuerpo de agua dentro o fuera del área del proyecto. Indique nombre del cuerpo de agua.

( ) Dentro ( ) Fuera Nombre _____

Tipo de canalización entubada _____ abierta _____

IV. Calidad de Aire

A. Fuentes de emisión atmosférica

Descripción	Existente	A construirse
Incinerador	( )	( )
*Caldera	( )	( )
Polvo fugitivo	( )	( )
Otros	( )	( )

* Si el proyecto conlleva el uso de calderas, se deberá suplir, en hoja aparte, la siguiente información:

1. tipo y cantidad de combustible a usarse
2. contenido de azufre en el combustible, expresado en porciento (%)
3. horario de operación del equipo
4. capacidad de la caldera en B.T.U.

B. Descripción del proceso de manufactura y/o detalles de las fuentes (proceso, producción mensual, etc.).

_____

_____

C. Control de contaminación atmosférica

Medidas que se implementarán para minimizar la contaminación atmosférica:

1. proceso _____ 3. emisiones fugitivas _____

2. equipo de combustión _____ 4. otros _____

V. Calidad de agua

A. Disposición de desperdicios sanitarios e industriales

1. Sistema sanitario propio

a) Planta de tratamiento _____

1. localización _____

2. sitio de descargar del efluente (nombre cuerpo) _____

_____

3. calidad de las aguas receptoras _____

_____

DBO _____

OD _____

Coliformes fecales

4. capacidad planta

5. tipo de tratamiento

b) Pozo séptico ( )

1. localización _____ 2. capacidad _____

2. Conectarse al sistema de A.A.A. ( )

a) localización _____

b) sitio de descargar del efluente (nombre cuerpo) _____

_____

c) capacidad planta _____

d) tipo de tratamiento _____

3. En caso de que el proyecto conlleve desperdicios industriales deberá indicar el método de disposición de éstos. _____

_____

_____

B. Abasto de agua potable

1. A.A.A. ( )

2. Hincado de pozo ( )

a) capacidad máxima extracción _____

b) promedio diario extracción _____

c) obtuvo permiso Departamento de Recursos Naturales

Sí _____ No _____

3. Otros (especifique)

_____

_____

_____

C. Sistema pluvial

1. sitio de descarga (indicar nombre del cuerpo receptor)

( ) mar _____

( ) río _____

( ) quebrada _____

( ) lago o laguna _____

( ) otros _____

2. capacidad del sistema

capacidad _____ pc/sec

actual _____ pc/sec

incremento de flujo propuesto _____ pc/sec

D. Discuta impacto efluente sanitario y pluvial en cuerpo de agua receptor

_____

VI. Desperdicios sólidos

A. Volumen

1. generados durante la construcción

descripción	volumen o peso estimado
( ) demolición	_____
( ) vegetación	_____
( ) otro	_____

2. generados durante operación normal del proyecto

descripción	volumen o peso estimado
_____	_____
_____	_____

B. Facilidades de almacenamiento

1. descripción _____

_____

2. ubicación _____

_____

C. Responsabilidad de recolección y disposición final

Persona u organización responsable		frecuencia
1. Durante construcción	_____	_____
2. Durante operación normal	_____	_____

D. Métodos recolección y disposición final

( ) incineración ( ) compactación ( ) municipio

VII. Aspectos socio-económicos

A. Razones

1. ¿Qué razones económicas y/o sociales motivaron el proyecto?

_____

_____

_____

2. ¿Por qué se seleccionó el lugar específico para la ubicación?

_____

_____

_____

3. Costo o inversión total del proyecto $ _____

B. Industria

Si el proyecto es industrial, provea la siguiente información:

1. Productos: _____

_____

2. Servicios: _____

_____

3. Es producto o servicio nuevo en Puerto Rico ( ) sí ( ) no

4. En qué otro lugar de la Isla se produce _____

_____

5. Consumo: ( ) local ( ) exportación ( ) ambos

C. Facilidades de Servicios

Indique el consumo de facilidades de servicios que requerirá el proyecto

( ) energía eléctrica _____KW/h ( ) agua _____mgd

( ) gas _____ ( ) otro _____ _____
cual unidad por día

D. Recursos Humanos

Indique la generación de empleos del proyecto

	número de empleos	
niveles de salarios anuales	durante la construcción	futuros permanentes
sobre $15,000	_____	_____
entre $10,000 y $15,000	_____	_____
entre $6,000 y $10,000	_____	_____
entre $3,000 y $6,000	_____	_____
menos de $3,000	_____	_____

E. Transportación

Cómo se afectará la transportación en el área

tipo	cantidad estimada de vehículos y pasajeros
( ) terrestre	_____
( ) aérea	_____
( ) marítima	_____

VIII. Agencias gubernamentales

Indique qué otras agencias gubernamentales podrían tener interés en el proyecto y sus razones _____

_____

_____

_____

APPENDIX VII

To Section 6: LEGAL AND REGULATORY FEASIBILITY

CONSTRUCTION AND USE PERMITS APPLICATIONS

ARPE-15.2
DIC. 1975

ESTADO LIBRE ASOCIADO DE PUERTO RICO
ADMINISTRACION DE REGLAMENTOS Y PERMISOS

SOLICITUD DE PERMISO PARA CONSTRUCCION

☐ Obra Hasta $ 3,000 ☐ Obra mayor de $3,000 Y menor de $15,000 ☐ Obra de $15,000 o más ☐ Enmienda (Favor complementar parte III)

I-INFORMACION GENERAL:

NUMERO DE RADICACION (Para uso ARPE)	
Número	Fecha

NUMERO DE CATASTRO				
Municipio	Mapa		Manzana	Parcela
	1:10,000	1:1,000		

PROYECTO		
Nombre		
Localización exacta		
	Estimado por Proyectista	Estimado por ARPE
Costo		

Si ha sido radicado anteriormente indique:		
	Número de Radicación	Fecha
Ubicación		
Desarrollo		
Anteproyecto		
Planos Finales		

IDENTIFICACION				
	Nombre	Dirección postal	Zip code	Teléfono
DUEÑO				
PROYECTISTA				

NOTA: Favor de indicar lo propuesto en primera línea y existente en segunda línea (Si aplica)

Distrito(s) de Zonificación	Altura máxima		Densidad Poblacional (m.c./u.b.v.)	Area del Solar (m.c.)	Area de Ocupación (m.c.)	Area bruta de piso (m.c.)	Tamaño de los patios (en metros)			
	Plantas	Metros					Delantero	Izquierdo	Derecho	Posterior

II-EDIFICACION:

A-TIPO DE PROYECTO

1-☐ Edificio nuevo
2-☐ Ampliación
3-☐ Alteración
4-☐ Reconstrucción
5-☐ Instalaciones de urbanizaciones
6-☐ Plano Modelo
7-☐ Otros _____ (Especifique)

B-Uso

RESIDENCIAL (Indique %)

1-☐ Una familia
2-☐ Dos o más familias (Indique núm. de unidades _____)
3-☐ Casas en hileras (Indique el núm. de unidades _____)
4-☐ Hotel (Indique el número de unidades _____)
5-☐ Otros _____ (Especifique)

No-RESIDENCIAL (Indique %)

1-☐ Industrial, almacén
2-☐ Comercial, oficina
3-☐ Educativo
4-☐ Institucional
5-☐ Facilidades recreativas
6-☐ Estacionamiento
7-☐ Otros _____ (Especifique)

C- Tipo principal de estructura

1-☐ Hormigón armado
2-☐ Hormigón armado y bloques
3-☐ Acero estructural
4-☐ Madera y combinaciones
5-☐ Otros _____ (Especifique)

D- Favor indicar con "x"

	Públicos	Privados
1. Disposición desperdicios sólidos		
2. Disposición aguas servidas		
3. Abastecimiento agua potable		

F- Fondos para el Proyecto (Indique %) Públicos _____ Privados _____

Especifique origen fondos públicos _____

E-Indique si la estructura tiene:

1-☐ Unidad de aire central
2-☐ Ascensor (Núm. _____)
3-☐ Incinerador
4-☐ Cisterna
5-☐ Piscina
6-☐ Estacionamiento (Indique núm. de espacios)
_____ dentro del edificio
_____ fuera del edificio
7-☐ Subestación (_____ KVA)
8-☐ Pozo séptico
9-☐ Areas de carga y descarga (Núm. _____)
10-☐ Niveles de sótanos o semisótanos (Núm. _____)

G – Favor de indicar la cantidad de G- casas o apartamentos de:

1-_____ Un dormitorio
2-_____ Dos dormitorios
3-_____ Tres dormitorios
4-_____ Más de tres dormitorios

H- Facilidades vecinales a proveerse (Indique %)

1-☐ Escuela
2-☐ Comercial
3-☐ Centro Comunal
4-☐ Recreación activa
5-☐ Recreación Pasiva
6-☐ Area de refugio

Area total en metros cuadrados _____

III-DESCRIPCION DE LA ENMIENDA (Para uso en caso de enmiendas)

Número de Radicación

(Para uso A R P E)

DECLARACION DEL DUEÑO O SOLICITANTE:

NOTA: Para ser complementado para los proyectos menores de $15,000 y que no se certifiquen de acuerdo al Reglamento de Planificación Número 12(Reglamento para la Certificación de Proyectos de Construcción).

Declaro que esta solicitud, incluyendo los documentos que se acompañan, ha sido examinada por mi y que según mi mejor información y creencia es cierta, correcta y completa.

Firma: _____
Solicitante

CERTIFICACION DEL PROYECTISTA :

NOTA: Para ser complementado para los proyectos que se certifiquen de acuerdo al Reglamento de Planificación Número 12 (Reglamento para la Certificación de Proyectos de Construcción).

En armonía con las disposiciones de la Ley Número 135, del 15 de junio de 1967, enmendada,

Yo_____ CERTIFICO:
Nombre y Apellidos

Soy mayor de edad, _____ y vecino de _____, Puerto Rico
Estado Civil Municipio

Soy _____ autorizado para ejercer la profesión en Puerto Rico con Licencia Núm._____
Ingeniero o Arquitecto

Estoy autorizado por_____ para radicar la solicitud y los planos y especificaciones que
Nombre del Dueño

acompañan la presente para:

☐ La _____ de un edificio o estructura
Const., Ampl., Etc.

en la calle _____ Núm. _____ en
Nombre Oficial

el Barrio/Urb. _____ de _____, P. R.

☐ Enmendar por _____ vez los planos de construcción
Primera, Segunda, Tercera, etc.

aprobados mediante el Permiso de Construcción Núm. _____

de fecha _____ de _____ de 19_____

Los planos y especificaciones que acompañan y forman parte de la presente, están en conformidad con las leyes y reglamentos aplicables en el Estado Libre Asociado de Puerto Rico, por lo cual solicito se me expida el correspondiente permiso de construcción.

En _____, Puerto Rico, a _____ de _____ de 19_____
Municipio

Firmado y sellado _____

(Para uso ARPE)

PERMISO DE CONSTRUCCION

Este permiso fue autorizado por.

☐ Ministerialmente ☐ Comité ☐ Junta

Mediante el informe Núm. _____

del Caso Núm _____

Aprobado: _____
Administrador de ARPE

Por: _____

Fecha Aprobado: _____

Recomendado por: _____

Fecha Expedido: _____

Este permiso debe cumplir con las siguientes condiciones especiales:

ARPE-15.9
DIC. 1975

ESTADO LIBRE ASOCIADO DE PUERTO RICO
ADMINISTRACION DE REGLAMENTOS Y PERMISOS

SOLICITUD DE PERMISO DE USO

I INFORMACION GENERAL:

RADICACION (Para uso ARPE)	
Número	Fecha

NUMERO DE CATASTRO				
Municipio	Mapa		Manzana	Parcela
	1:10,000	1:1,000		

PROYECTO	
Nombre	
Localización exacta	

Si ha sido radicado anteriormente indique:		
	Número de Solicitud	Fecha
Ubicación		
Desarrollo		
Anteproyecto		
Planos Finales		

IDENTIFICACION				
	Nombre	Dirección postal	Zip code	Teléfono
DUEÑO DE LA PERTENENCIA				
CONTRATISTA				
INSPECTOR				

Yo _____ solicito Permiso de Uso para ocupar la siguiente
(Nombre del Solicitante)

pertenencia:

☐ Solar ☐ Edificio ☐ Local

II Detalles de Uso:

Edificio Principal	
Planta	Uso Propuesto
Sotano	
1ra.	
2da.	
3ra	
4ta.	
5ta.	
Otras	
Accesorios	
2da.	

PERMISO DE USO

Recomendado por:

_____
Funcionario y Título Oficial

Aprobado por:

_____
Administrador de A R P E

Autorizado por:

_____

Fecha aprobado _____

Condiciones Especiales:
(No llene, para uso de ARPE)

Número de Radicación

(Para uso A R P E)

Declaración del Solicitante

Nota: Para ser Complementado para proyectos menores de $15,000 y que no se certifiquen de acuerdo al Reglamento de Planificación Número 12 (Reglamento para la Certificación de Proyectos de Construcción).

Declaro que esta solicitud ha sido examinada por mí y según mi mejor información y creencia es cierta, correcta y completa.

_____
Firma del Solicitante

Certificación del Inspector:

Nota: Para proyectos que se certifiquen de acuerdo al Reglamento de Planificación Número 12 (Reglamento para la Certificación de Proyectos de Construcción).

En armonía con las disposiciones de la Ley Número 135 del 15 de junio de 1967, enmendada, Yo

_____ CERTIFICO:
Nombre y Apellidos

Soy mayor de edad _____ y vecino de _____, Puerto Rico.
Estado Civil Municipio

Soy _____ autorizado para ejercer la profesión en Puerto Rico con Licencia Núm. _____
Ingeniero o Arquitecto

Soy el inspector designado por _____ para la inspección de las obras de
Nombre del dueño del proyecto

_____ autorizadas mediante el Permiso de Construcción número _____
construcción, ampliación, etc.

de fecha _____ de _____ de 19_____

La construcción de dicha obra fue inspeccionada por mí, y que la misma cumple con lo expresado en el permiso otorgado en base a los planos certificados por el _____
Ingeniero o Arquitecto (Nombre del Ingeniero o Arquitecto)

Licencia Núm. _____

_____
Firma del Inspector

Certificación del Contratistista o Constructor:

Para proyectos que se certifiquen de acuerdo al Reglamento de Planificación Número 12 (Reglamento para la Certificación de Proyectos de Construcción)

En armonía con las disposiciones de la Ley Número 135 del 15 de junio de 1967 enmendada Yo _____
Nombre

_____ CERTIFICO BAJO JURAMENTO:
y Apellidos

Soy mayor de edad, _____ y vecino de _____ Puerto Rico. Mi relación con la obra autorizada mediante el Permiso de Construcción Número _____ expedido con fecha _____ de _____ de 19____, es la descrita abajo en el párrafo _____
(a) (b) (c)

(a) Soy el _____ que ejecutó dicha obra.
contratista, constructor

(b) Soy el representante autorizado del _____ que ejecutó dicha obra
contratista, constructor (nombre del contratista o constructor)

(c) Soy _____ de la firma constructora _____ que
título del puesto Nombre legal de la firma

ejecutó dicha obra y ha sido autorizado por la corporación antes señalada mediante la Resolución Número _____ del _____ de _____ de _____ a firmar la presente certificación.

La obra de _____ fue ejecutada de acuerdo a los planos y especificaciones
construcción ampliación, etc.

sobre los cuales se otorgó el permiso de construcción.

Declaro bajo las penalidades de perjurio que esta Certificación ha sido examinada por mí y según mi mejor información y creencia es cierta, correcta y completa.

_____
Affidavit número

_____
Firma del Contratista o Constructor

APPENDIX VIII

To Section 8: INSTITUTIONAL & SOCIAL FEASIBILITY

PRWRA RESPONSE TO ER&A INTERIM REPORT

ESTADO LIBRE ASOCIADO DE PUERTO RICO

Autoridad de las Fuentes Fluviales de Puerto Rico

San Juan, Puerto Rico

DIRECCION TELEGRAFICA
[illegible]
DIRECCION TELEX AC
[illegible]

APARTADO 4267
00936

17 de enero de 1979

Ing. Frank Castellón, Director
Oficina de Energía
Estado Libre Asociado de Puerto Rico
Apartado 41089, Estación Minillas
Santurce, Puerto Rico 00940

Estimado ingeniero Castellón:

Adjunto los comentarios de la Autoridad de las Fuentes Fluviales al informe interino preparado por la compañía Energy Research & Applications sobre la viabilidad de generación hidroeléctrica en la presa de Patillas. Espero que estos comentarios reciban la debida atención.

Agradezco la oportunidad que se nos ha brindado para cooperar en este estudio.

Cordialmente,

Alberto Bruno Vega
Director Ejecutivo

Anexo

COMMENTS OF THE PUERTO RICO WATER RESOURCES AUTHORITY TO THE INTERIM REPORT ON THE HYDROELECTRIC FEASIBILITY ASSESSMENT OF PATILLAS RESERVOIR, PUERTO RICO

I. INTRODUCTION

Dated November 3, 1978 the company Energy Research and Applications, Inc. issued an interim report on their feasibility study for the operation of a low-head hydroelectric plant at the Patillas reservoir. This reservoir is part of the south-east irrigation district of Puerto Rico, operated by the Puerto Rico Water Resources Authority (PRWRA) for the Government of Puerto Rico. Following are PRWRA's comments to the subject report. The comments will address the issues in the same order that they are presented in the report.

II. COMMENTS

Part 1.0 Management Report and Patillas Project Description

Page 1, Paragraph 5

The Authority objects to the full contents of the paragraph.

We are interested in this project because if the assessment is properly carried out, it may produce useful information to support our plans for the intensive use of our renewable energy sources. The Authority has not only been cooperative with studies of this type, but it has undertaken a number of analyses and is participating in several efforts to assess the potential of our indigenous energy sources in order to exploit them for the benefit of Puerto Rico and the Nation. Some of the energy sources that have been subject of analysis or that are receiving our attention and

efforts are: geothermal, wind, ocean thermal, and solar radiation. On the field of wind power an experimental 200 Kw machine is being tested under cooperative agreement No. EG-77-A-01-4100 with the Department of Energy of the United States.

Page 3, paragraph 2

It is an overstatement to say "The timing and probable result of this study... is serving as an incentive for the Authority to accelerate its actions to decrease oil-fired thermal power dependency islandwide". Such actions and such decisions are taken based on a broader and deeper analysis of the world energy situation, and its impact on Puerto Rico. Of course, we welcome this study because it may produce valuable information for the assessment of our hydro electric potential.

PART 1.1 Rationale for Specific Prime Design

Page 4, item 4)

PRWRA does not own the property on which the powerhouse would be located. PRWRA is in charge of the property as part of its functions in the administration of the irrigation service.

1.1.1 Engineering Feasibility and Design Concept for Hydropower Retrofit.

Page 5, paragraph 2

We would like to caution that to change the way in which the water is currently used, the existing law establishing water rights has to be amended.

PART 3.0 Hydrologic Analysis for Feasibility Determination

Page 30, paragraph 2

We caution on the use of peak demand data obtained from a California based power company. The electric power system of Puerto Rico operates at a load factor of over 75%, which is much higher than in many U. S. locations. Seasonal variation in Puerto Rico is very small. PRWRA's Planning Division uses an estimate of twelve daily hours (from 10:00 a.m. to 10:00 p.m.) except Saturdays, Sundays, and holidays to represent the peak hours during the month. Although these days may vary slightly from one year to another, the following table gives the number of days where peak demands are forecasted during the year 1979:

Month	No. of Peak Day	Month	No. of Peak Day
January	21	July	18
February	19	August	23
March	21	September	19
April	19	October	21
May	22	November	19
June	21	December	20

Page 30, paragraph 3

In order to make maximum use of the water received by the reservoir, we would recommend to operate the proposed installation as a peaking unit. The design should consider a large unit to operate not over twelve hours a day.

PART 4 - Economic Feasibility

Page 37, Foot-Note

Residential customers who use 425 Kwh or less do not pay the Authority's fuel adjustment charge corresponding to the first 400 Kwh. They pay fuel adjustment fo

for the excess over 400 Kwh. The note should be revised accordingly.

Page 38

The economic model being developed to encompass all of the factors to be considered should be expressed as the total cost of producing one kilowatt-hour with hydro power versus the corresponding total cost of producing one kilowatt-hour with a comparable thermal plant. This total cost should include annual investment, operation and maintenance, and fuel (if applicable). The thermal plants to be taken as reference should be both a steam unit and a gas turbine. In either case, their corresponding characteristics should be used in the model.

PART 5 - Environmental Baseline as Determined by the CEER of Puerto Rico

SUMMARY

Page 3, paragraph 2

This paragraph and other sections of this report, give the impression that the waters of the reservoir are receiving little use. We caution that these waters are committed for agricultural, domestic and industrial consumption. The condition that maintained the lake "often full" during the past year might be incidental to unusually heavy precipitation and a temporary reduction in agricultural use. At present there are no known plans to reduce the agricultural commitment of these waters.

Page 5, paragraph 1

The dam provides a usable storage capacity of about 17 million cubic meters instead of the expressed 23 million.

Page 5, paragraph 2

Rainfall in Patillas occur primarily from May to November, instead of the expressed August to December.

The main purpose of the new spillway constructed in 1976 was to increase the capacity of the reservoir by raising the level of the spillway. This new spillway has reduced water losses and therefore accounts for the higher water levels that can be reached at present.

PART 8.0 Interim Report on Social and Institutional Effects

Page 45, paragraph 1

PRWRA does not own the site as expressed in this paragraph. PRWRA is the administrator of the Irrigation System and as such is in charge of the site.

The Board is composed of seven (7) members on which five (5) members are appointed by the Governor of Puerto Rico with the consent of the Senate and the other two (2) members are elected by the electric power consumers.

Page 45, paragraph 2

The contents of this paragraph is wrong. PRWRA is strongly in favor of the use of those alternate energy sources that may be viable in Puerto Rico and that may prove beneficial to our country. There will be no undue lag in implementing a policy in favor of the exploitation of our hydraulic resources if such policy is properly supported and adopted at the required government and PRWRA levels.

Page 46, paragraph 2

It is completely wrong to indicate that PRWRA has made a committment to the development of nuclear power installation. Our only nuclear project has been postponed

indefinitely. Future expansion of generating capacity in Puerto Rico will be made as usual, based on thorough analyses and evaluations. They will never be made on capricious selection of a particular alternative.

Page 46, paragraph 3

It is completely wrong to say that "hydropower is difficult to sell as an alternative to nuclear power" despite favorable factors. If such favorable factors are shown by the study, the approach should be made to PRWRA, which is the entity capable of actual development and operation of hydroelectric facilities in Puerto Rico.

PART 8.3 Social Climate

Page 47, paragraph 1

The average purchase price of electricity:

Industries $0.04025/KWh
Municipalities (Public Lighting Only) $0.117/KWh
Municipalities (Offices) $0.065/KWh

Page 47, paragraph 2

It is incorrect to say that most existing impoundments in Puerto Rico were constructed for the purpose of flood control. The impoundments were constructed mostly for irrigation and for potable water use. Flood control has been incidental to those main purposes.

Page 47, paragraphs 3 and 4

It should be clearly understood that irrigation has the top priority at this moment; however, power generation can be undertaken if properly coordinated with this and the other uses.

Page 48, paragraph 2

It is wrong to suggest that resentment might exist at the very presence of a federally supported project in Puerto Rico. Federal projects are very common in our island and they seldom give way to resentment or protests. In fact, the project of the wind turbine generator under test and demonstration at our municipal island of Culebra is being carried out without a single known voice of protest. To the contrary, we have every reason to believe that the public will welcome the use of our renewable energy sources like wind power, hydroelectric power and others.

PART 8.4 Political Climate

This whole section should be eliminated. We don't consider advisable mentioning names of any particular political party in a technical document like this. It doesn't add much to the report; on the contrary, it may give rise to unneeded responses from sectors that have been indifferent or passive in the presence of these projects.

PART 8.5 Addendum to the Interim Report on Social and Institutional Effects

Page 50, paragraph 4

We object to the contents of this paragraph. Energy use decisions made by PRWRA are based on the government policy which is established for the benefit of our consumers. Careful analyses and serious discussions precede these decisions which are approved by the Governor and the Governing Board.

Page 51, paragraph 2

It is wrong to believe that PRWRA is insensitive to fuel price increase because oil costs can be passed directly to the consumers. PRWRA is a government corporation entitled to give electric power to our consumers at the lowest possible cost. Therefore, it is part of our mission to search for lower price energy sources in order to benefit our consumers.