Stantec

REPORT

HYDOELECTRIC REDEVELOPMENT

ARGO AND GEDDES DAMS FEASIBILITY STUDY

CITY OF ANN ARBOR

JULY 2008

Prepared By:

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3959 Research Park Drive
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July 2008

Job No: 2075109900

Table of Contents

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 PURPOSE

The City of Ann Arbor commissioned Stantec Consulting Michigan Inc. (Stantec) to provide data for assistance in evaluating feasibility of redeveloping hydroelectric power facilities at the Argo and Geddes Dams within the City of Ann Arbor, Michigan. Specific data to be provided includes an estimate of the site power potential, estimate of redevelopment costs, including both initial capital cost and ongoing operation costs, and investigation into Federal Energy Regulatory Commission (FERC) licensing requirements. This data will be used by the City of Ann Arbor to evaluate the economic feasibility of redevelopment. The study is an update to a previous (1982) study performed by Stantec (formerly Ayres, Lewis, Norris & May, Inc.).

1.2 SUMMARY

Results of Stantec's preliminary investigation into reinstallation of hydroelectric power at Argo and Geddes Dams are summarized as follows:

1. Argo Dam

   - The recommended installed capacity is 370 kw, which corresponds to 28% flow exceedance (536 cfs), i.e. the river flow will exceed the turbine rated hydraulic capacity 28% of the time.

   - The estimated average annual power generation is approximately 2,000,000 kwh/yr.

   - The preliminary estimate of probable project cost is $4,350,000, which includes indirect costs such as engineering, licensing/permits, finance, legal and contingencies.

   - In addition to initial capital expenditures, there will be ongoing annual expenses associated with plant operation and FERC license requirements. Based on historical data for the Barton and Superior plants, as compared to Argo and Geddes, the net additional operation and maintenance cost is estimated to be approximately $70,000/year (excluding debt service).

   - The preliminary development concept includes installation of a single 1,700mm bulb or pit double regulated propeller turbine with speed increaser and high speed generator. It is proposed to locate the power house adjacent to the left (east) side of the spillway. Locating the power house at the end of the existing millrace was evaluated and determined to be impractical due to high cost, minimal additional power production and environmental considerations.

- Generated power would be interconnected to the existing power grid adjacent to the site.

2. Geddes Dam

- The recommended installed capacity is 670 kw, which corresponds to 23% flow exceedance (633 cfs).
- The estimated average annual power generation is approximately 3,350,000 kwh/yr.
- The preliminary estimate of probable project cost is $4,350,000, which includes indirect costs such as engineering, licensing/permits, finance, legal and contingencies.
- In addition to initial capital expenditures, there will be ongoing annual expenses associated with plant operation and FERC license requirements. Based on historical data for the Barton and Superior plants this cost is estimated to be approximately $70,000/year (excluding debt service).
- The preliminary development concept includes installation of a single 1,700mm bulb or pit double regulated propeller turbine with speed increaser and high speed generator. It is proposed to locate the power house in the center island between the existing spillways.
- Generated power would be interconnected to the existing power grid adjacent to the site.

Should the City determine to further pursue redevelopment of either or both sites, it is recommended that the next phase of effort include performance of the following tasks in order to further validate preliminary assumptions/analysis:

- Confirm power production estimates by obtaining additional tailwater information, particularly at Geddes Dam.
- Confirm estimated project cost by developing more detailed preliminary drawings and associated estimates of cost.
- Hold further discussion with environmental resource agencies (MDNR, MDEQ, and USFWS) regarding potential environmental concerns, studies and license conditions.
- Perform detailed studies of power markets and potential sale rates.

2.0 BACKGROUND

2.1 BACKGROUND

The City of Ann Arbor owns four dams on the Huron River: Barton, Argo, Geddes, and Superior. Following a 1981 study of the hydroelectric generation potential at all four City dams by Ayres, Lewis, Norris and May, Inc, the citizens of Ann Arbor approved a $3.2 million bond to restore hydropower at Barton and Superior Dams. Higher construction cost estimates and lower electric production potential kept Argo and Geddes from being recommended for restoration at that time. Economic analysis of the hydroelectric potential was based on 1981 electric costs of 3.1 cents/kwh and bond interest rates of 10.5%.

In 2006, the Ann Arbor City Council passed a resolution calling for the City to use 30% renewable energy in its municipal operations by 2010, and 20% community-wide by 2015. Renewable electricity generated by City-owned dams may make a significant contribution toward meeting these goals. Given the City's push for renewable energy, today's electricity generation costs at 5-6 cents/kw, the increased value of "green" energy (1-2 cents/kwh over tariff prices) and lower interest rates available (5% or lower), it is important to re-evaluate the hydropower potential of Argo and Geddes Dams.

The City has also begun the Huron River and Impoundment Management Planning (HRIMP) process, a comprehensive, multi-stakeholder study of the stretch of the river that runs through Ann Arbor. An updated assessment of the hydroelectric potential of the City's dams will allow the HRIMP committee to make informed recommendations regarding the future of the Huron River.

Toward these ends – meeting renewable energy goals and developing a management plan for the Huron River – it is important to better understand the value of the City's dams for hydroelectric generation. This study will assist the City of Ann Arbor in making decisions about the future of its dams, the Huron River, and renewable energy in Ann Arbor.

2.2 POWER POTENTIAL

The theoretical power potential of a hydropower site is dependent on three factors:

1. the net hydraulic head (gross hydraulic head minus system headloss);
2. mean available stream flow;
3. plant efficiency (efficiency of the power producing equipment).

The relationship of these factors is given by the following formula:

$$\text{Power (kw)} = \frac{(\text{Head (ft.)})\ (\text{Flow (cfs)})\ (\text{Efficiency (\%/100)})}{11.8}$$

To determine values for the first variable, net head, we measured the gross head at each site under both normal and above normal flows. Two readings were taken for the purpose of this preliminary study, however, should the City desire to proceed to the next phase of investigation, additional readings should be taken over a range of flows, especially with regard to the tailwater elevation at the Geddes Dam. At both the Argo and Geddes dams, the headwater (impoundment) elevation is maintained relatively steady by operation of the floodgates. The tailwater (downstream) elevation increases with flow, which results in reduced gross head as the flow increases. For the purpose of this preliminary study, the gross head is reduced by 0.5 feet to compute net head available. The 0.5 foot headloss is attributed to system losses in the powerhouse forebay/intake. Net head available for power production for each site is shown in the power production tables included in **Appendix D**. Note that for Argo Dam, the option of placing the powerhouse at the end of the existing millrace results in an additional two feet of net head.

The second variable, flow, was determined by comparing MDEQ provided flow exceedance data to historic USGS gage data for USGS Gage No. 04174500, which is located near Maiden Lane, approximately 0.7 miles downstream from Argo Dam. Both MDEQ and USGS data are shown in **Appendix A**. The data compared favorably for normal to above normal flows. The MDEQ data resulted in slightly less flow in the lower (greater than 50% exceedance) flow range. For the purpose of this study we used the more conservative (MDEQ) values in computing potential site power.

The third variable, plant efficiency, is the function of the combined efficiencies of the various mechanical/electrical equipment components i.e. turbine, speed increaser, generator and transformer. In addition, an allowance for station power usage is typically applied. Equipment efficiencies are variable with load typically maximizing near rated load and decreasing as the load decreases. For the purpose of this study, these efficiencies were taken from equipment manufacturer quotations. The manufacturer quotes include turbine, speed increaser, and generator efficiencies. A further reduction of 2% is assumed for transformer efficiency and station power usage.

In order to compute estimated power production, a hydraulic capacity must be selected for each site. Hydraulic capacity is defined as the rated maximum flow that the turbine(s) will pass. The selection of the optimum hydraulic capacity at a hydroelectric site typically requires a detailed cost benefit analysis for various capacity options. Due to the variable flow rates, resource plant capacity is inversely proportional to plant utilization i.e. the higher the selected capacity, the lower the percentage of time that the unit will operate at the rated capacity. It is typical to see sites developed to 25% exceedance flow. We requested manufacturer quotes of 25%, 50% and

75% exceedance; however, based on discussion with the manufacturers, settled on an approximate 25% exceedance for hydraulic capacity.

The impact of potential downtime due to equipment maintenance, facility upkeep and low flow must also be taken into consideration. For the purpose of this study, the average annual generation is reduced by 10% for this consideration. This is conservative by industry standards; however, historic records indicate that Barton and Superior have experienced reductions of 13% and 19% respectively.

The resultant power production calculations are shown in **Appendix D**. Please note that computations were made for two equipment suppliers, Canadian Hydro Components and Ossberger Turbines (HTS, Inc.). For presentation purposes, we have selected Canadian Hydro Components data. Power production statistics are summarized as follows (for the purposes of comparison, figures from the 1982 study are also included):

Argo Dam	2008	1982
Installed hydraulic capacity	536 cfs (28% exceedance)	--
Installed generating capacity	370 kw	450 kw
Estimated average annual energy	2,000,000 kwh/yr	1,646,000 kwh/yr
Estimated average annual utilization	62%	42%

Geddes Dam	2008	1982
Installed hydraulic capacity	633 cfs (23% exceedance)	--
Installed generating capacity	670 kw	570 kw
Estimated average annual energy	3,350,000 kwh/yr	2,196,000 kwh/yr
Estimated average annual utilization	57%	48%

Historical production data is available at the Barton and Superior dams, which can be evaluated for comparative purposes. It should be noted that the head/flow characteristics of Superior site closely match those at Geddes Dam. The historical production data is included in **Appendix E**. A review of this data indicates the following (1982 estimated data included for comparison):

Barton Dam	Actual	1982 Study
Installed generating capacity	900 kw	900 kw
Average Annual Energy	4,220,000 kwh/yr	3,600,000 kwh/yr
Maximum Annual Energy	7,449,000 kwh/yr	--

Barton Dam	Actual	1982 Study
Minimum Annual Energy	585,000 kwh/yr	--
Average Annual Utilization	54%	46%
Maximum Annual Utilization	95%	--
Minimum Annual Utilization	7%	--

Superior Dam	Actual	1982 Study
Installed generating capacity	570 kw	590kw
Average Annual Energy	2,294,000kwh/yr	2,426,000kwh/yr
Maximum Annual Energy	4,174,000 kwh/yr	--
Minimum Annual Energy	354,000 kwh/yr	--
Average Annual Utilization	46%	47%
Maximum Annual Utilization	84%	--
Minimum Annual Utilization	7%	--

As can be seen, the Barton facility has exceeded the 1982 projections, while Superior has not met the estimated production. Based on discussion with operations personnel, downtime due to equipment repairs appears to be the cause of the Superior deficiency.

It should be noted that while the Superior site characteristics are very similar to Geddes, the estimated production at Geddes is significantly greater than that experienced to date at Superior (3,350,000 kwh/yr versus 2,294,000 kwh/yr). The main reason for this is the recommended installed capacity and assumed utilization rate are both greater than Superior's historical performance.

3.0 DEVELOPMENT CONCEPT

3.1 EQUIPMENT

Stantec sought input/proposals from six equipment manufacturers to determine the most appropriate type of equipment. Their responses are included in **Appendix B**. A brief summary of responses follows:

1. **Canadian Hydro Components Ltd.**

   Single, 1,700 mm, double regulated propeller pit turbine with synchronous generator and switchgear at each site.
   Argo – 387 kw; Geddes – 652 kw.
   Budget Price for Supply $1,185,000 each.

2. **Hydropower Turbine Systems, Inc.** [(1)]

   Single, 2,000 mm (Argo); 1,780 mm (Geddes), double regulated bulb turbine with induction generator.
   Argo – 525 kw; Geddes – 725 kw.
   Budget Price for Supply $797,000 (Argo)
   $839,000 (Barton)

[(1)] Stantec's estimate to add switchgear and controls and synchronous generation is $250,000 each.

3. **James Leffel Co.**

   No response.

4. **Norcan Hydraulic Turbines**

   No response.

5. **VA Tech Hydro**

   Single, 1,950 mm (Argo); 1,770 mm (Geddes), double regulated S-type (propeller) turbine with synchronous generator, switchgear and controls.
   Argo – 400 kw; Geddes – 470 kw.
   Budget Price for Supply $3,490,000 (Argo)
   $3,290,000 (Barton)

6. **Voith Siemens**

   Single, 2,100 mm, double regulated S-type (propeller) turbine with synchronous generator (no switchgears).
   Argo – 400 kw; Geddes – 700 kw.
   Budget Price for Supply $5,750,000 for both.

Based on review of this information and for the purpose of this preliminary investigation, it was determined to utilize the Canadian Hydro Components Ltd. proposal for detailed evaluation and costing. Pit turbines such as that proposed by Canadian Hydro have been recently utilized on numerous low head sites. They are believed to offer an efficient powerhouse footprint and effective use of the power (water) resource. The proposed unit is essentially a horizontal axial flow (or propeller) unit. Double regulated relates to the fact that both the runner pitch and wicket gates are adjustable. Their position is varied with flow to achieve maximum efficiency over a wide range of flows. In this case, the proposed turbine will operate from 120 cfs-550 cfs (Argo); 125 cfs-650 cfs (Geddes). This will essentially mean that the units can operate down to 90% exceedance at these sites while still achieving the goal of having a rated capacity near 25% exceedance flow (Argo 28% exceedance; Geddes 23% exceedance). The turbines will operate at 200 RPM (Argo) and 240 RPM (Geddes), which will be increased to 720 RPM by a parallel shaft speed increaser similar to those that are installed at Barton and Superior dams. The high speed generators will be synchronous. Switchgear with utility grade relays and metering will be installed at each site. It is assumed that the produced power will be sold to the local utility (Detroit Edison Co.) and thus a transformer will be required to step voltage up to local grid specifications. At both sites, grid interconnection is available in close proximity to the proposed powerhouse.

3.2 CIVIL WORKS

The civil works for each site will be similar. A rough preliminary layout is shown in **Appendix C**. Beginning at the upstream of the facility, the various civil works components are described as follows:

- The preliminary location of the proposed powerhouse at Argo is to the left (east) and adjacent to the existing spillway. This location is selected as it represents the most cost effective civil works option. It is envisioned that the powerhouse would be placed at a slight (approximately 30 degree) angle to the spillway to facilitate integration with the existing embankment and to optimize hydraulic efficiencies. This location is at, or near, the original spillway location and, depending on the extent of removal, some debris may be encountered during excavation. It should also be noted that existing vegetation (trees and brush) will need to be removed from the embankment. It appears that the proposed powerhouse location is outside of the limits of the endangered species (purple turtlehead) which exists on the embankment; however, further investigation is needed to confirm this fact. The option of locating the powerhouse at the end of the existing millrace was evaluated and determined to be impractical. This location results in an increased head of two feet; however, installation costs associated with stability enhancements to the millrace berm are expensive and environmentally obtrusive due to exiting vegetation, including the aforementioned endangered species (purple turtlehead). In order to negate the need to work on this embankment, we evaluated the installation of a penstock in the millrace. A twelve foot diameter penstock would be needed, which would cost approximately $3 million.

- It is proposed to locate the proposed powerhouse at Geddes, between the two existing spillways. Should further investigation prove this to be unfeasible, then locating the powerhouse left (north) of the existing left (north) spillway should be investigated. The mid-spillway location is believed to be optimum from a hydraulic standpoint. The impoundment depth is greater at this location, which should positively influence intake hydraulics. This location will result in a fairly compact, but workable, powerhouse/spillway setting with easy access from the downstream roadway.

- Impoundment dredging. Some dredging of the impoundment is anticipated in order to lower the proposed intake elevation to provide adequate intake submergence. Since the Argo Dam has a lower head than Geddes, the dredging depth footprint and volume will be greater. At Geddes, the impoundment was dredged to the needed elevations in 1970 as part of the spillway reconstruction. It is assumed that some siltation has taken place since that date, which will require removal. For the purpose of this study, it is assumed that two feet of silt will be removed throughout the front of the spillways and proposed powerhouse.

- The intake trash rack is sized to provide minimal intake velocities at the trash racks. We do know from discussion with the Michigan Department of Natural Resource (MDNR), Fisheries Division, that it will be their preference to have an intake at the lower elevations of the impoundment. This is preferred in order to provide mixing of impoundment waters in order to minimize temperature stratification in the vertical water column. The MDNR also indicated that fish protection would need to be evaluated in the intake design. The concern is for turbine mortality for the various fish species. For the purpose of this study, we will assume an intake velocity of 1.5 ft/sec and an intake bar spacing of 1-inch clear spacing. This should result in a net velocity through the racks of approximately 2 ft/sec, which by industry standards is typically satisfactory for fish entrainment and mortality concerns. The resultant trash rack size is 14-feet high by 36-feet wide. The bottom of the racks would be placed 15-feet below normal headwater i.e. top of rack would be 1-feet below normal headwater. A concrete breast wall with access platform for cleaning the racks would be provided. It should be noted that at Geddes, the bottom elevation of the proposed intake appears to be above the elevation of the existing right (south) spillway and slightly below the elevation of the existing left (north) spillway. This is based on review of the 1970 reconstruction drawings, and should be confirmed through further review of the original Geddes powerhouse drawings. If this is confirmed, then some protection of the left (north) spillway will be required during excavation to prevent undercutting of that spillway. An allowance has been provided in the preliminary cot estimate for this work.

- The forebay section of the powerhouse will be a transition from the trash rack section to a narrower turbine intake. It is proposed that this would be a open-flume concrete lined forebay. The convergence angle should be maintained between 15 and 30 degrees. A head gate is placed at the downstream terminus of the forebay used for dewatering of the powerhouse. For the purpose of this study, we have assumed a permanent, steel bulkhead head gate with lifting superstructure and crane. This head gate would be approximately 15-feet wide by 15-feet high.

- The powerhouse substructure will be sized to accommodate the proposed turbine, speed increaser and generator. Fabricated steel access stairs, railings and platforms will be used to enhance operator access. A removable hatch will be placed above the turbine generator equipment for maintenance removal of these equipment components, should that be required. A masonry powerhouse superstructure is envisioned. This would be a single story structure and would house switchgear and station power equipment, as well as provide access to the powerhouse substructure.

- A reinforced concrete draft tube approximately 10-feet high by 15-feet wide would be placed beneath the existing roadway with an exit point at the existing downstream retaining wall between the two spillways. This retaining wall would be reconstructed with a new reinforced concrete retaining wall. A fabricated steel tailgate, 15-feet wide by 10-feet high, is assumed. No lifting structure or crane is assumed as the gate would be installed by a portable crane located on the nearby roadway.

- Tailwater dredging would be required since the discharge elevation will be beneath the existing stream bed. This excavation, which would be sloped at approximately 1 vertical to 4 horizontal, would be lined with heavy riprap to prevent stream bed scour.

- Produced power would be interconnected to the existing utility grid. In the case of Argo Dam, there is an existing transmission line which follows the north side of the millrace to an existing switch yard adjacent to the historic powerhouse. In the case of the Geddes Dam, there is existing electrical distribution transmission lines on either side of the river with an existing switch yard located on the right (south) side of the river a few hundred feet from the spillway. A detailed evaluation will need to be performed to determine the proper interconnect point.

A preliminary estimate of probable cost has been prepared for the above described development option. The estimate was performed at the Geddes site, but since the development options for the two sites are similar, it is anticipated that the estimated cost at Argo will also be similar. A summary of the estimated probable cost is shown in Table 1. The subtotal for the direct construction cost is approximately $3,328,000. After including indirect costs the total estimated probable project cost increases to $4,358,000.

TABLE 1
PRELIMINARY ESTIMATE OF PROBABLE COST

DIRECT CONSTRUCTION COSTS	
Mobilization	$ 90,000
Site Clearing/Soil Erosion Control (SEC)	$ 11,000
Dewatering	$ 245,000
Demolition	$ 30,000
Earthwork	$ 311,000
Concrete Work	$ 830,000
Powerhouse Superstructure	$ 106,000
Miscellaneous Metals	$ 83,000
Turbine Generator Equipment	$ 1,410,000
Electric Interconnection	$ 151,000
Controls/Instrumentation	$ 40,000
Site Improvements	$ 21,000
Subtotal Direct Construction Cost	$ 3,328,000
INDIRECT COSTS	
Licensing/Permits	$ 300,000
Engineering	$ 350,000
Legal/Financial	$ 50,000
Contingency (10%)	$ 330,000
Subtotal Indirect Costs	$ 1,030,000
TOTAL PRELIMINARY ESTIMATE OF PROBABLE COST	$ 4,358,000

4.0 LICENSE/PERMITS

4.1 LICENSE/PERMITS

As is the case with the existing Barton and Superior sites, any hydroelectric redevelopment will require that the City file for an operating license from the Federal Energy Regulatory Commission (FERC). One exception to this rule may be if the City were to utilize all generated power internally. In other words, the proposed facility, including interconnected loads, would be completely off grid. In this case, the City could confirm the need for a FERC license by applying to FERC for a Determination of Jurisdiction. **Appendix F** contains more information on the FERC licensing process, including the procedure for jurisdiction determination.

An allowance of $300,000 has been provided in the preliminary estimate of probable cost for the FERC licensing. This cost is highly dependent on the number and extent of environmental studies required to be performed as part of the license application. A copy of the MDNR/MDEQ study guidelines for FERC licensing is attached in **Appendix G**. Per conversations with MDNR/MDEQ representatives, it can be expected that a thorough review of environmental issues will be required as part of any FERC license process. Should the City desire to move to the next phase of effort, further communication with resource agencies is recommended.

In addition to the cost for filing the FERC license, it can be expected that there will be additional conditions imposed and obligations to be met as part of the FERC license. Many of these relate to dam safety issues as FERC has a rigorous dam safety program. Both the Barton and Superior sites have experienced this oversight and associated costs. These costs are included as on-going operation costs and are included in our annual estimate of $110,000/yr/site, which is based on historical data from the Barton and Superior sites. One item which highlights the impact of the FERC license requirements regarding dam safety is establishment of the inflow design flood (IDF), or spillway design flood as it is sometimes termed, for FERC sites. Under the State of Michigan jurisdiction, the spillway design flood is defined as a 200 year flood for high hazard dams such as the Argo and Geddes sites. This is a little less than 10,000 cfs for these sites. Under FERC guidelines, the inflow design flood must meet Probable Maximum Flood (PMF) criteria, which has been estimated to be approximately 23,000 cfs. Neither the Argo nor the Geddes dams have adequate spillway capacity to meet the PMF flows. In this case, FERC allows the applicant to perform an incremental hazard evaluation to determine if the inflow design flood can be established at a flow lower than the PMF. This study was performed for both the Barton and Superior sites, which resulted in an IDF of 0.6 and 0.7 PMF respectively. It is anticipated that this study will be required at both the Argo and Geddes sites should they be developed. While FERC does not require this study to be performed as part of the license process (it is typically performed as part of the initial Part 12 Safety Inspection Report) it would be prudent for the City to undertake this study in order to determine if indeed the IDFs can be lowered within the existing spillway capacity. If not substantial expense could be incurred to increase the spillway capacity at each site. Further study is needed to determine how this could best be accomplished; however, it is possible that this could involve millions of dollars at each site.

APPENDIX A
Flow Data

MDNR
Flow Data

Dougherty, Dana

From: DEQ-LWM-QREQ DEQ-LWM-QREQ [DEQ-LWM-QREQ@michigan.gov]
Sent: Tuesday, May 06, 2008 10:16 AM
To: Dougherty, Dana
Cc: Byron Lane
Subject: Re: flood or low flow discharge request (ContentID - 168812)

Attachments: ExceedanceCurvesForDams.xls; ExceedanceCurvesForDams.doc

ExceedanceCurvesForDams.xls (2... ExceedanceCurvesForDams.doc (3...

Here are the exceedance flows.

Thanks.

>>> <Dana.dougherty@stantec.com> 4/8/2008 8:22 AM >>>
Requestor: Dana M Dougherty
Company: Stantec Consulting Michigan, Inc
Address: 3959 Research Park Drive
City: Ann Arbor, MI
Zip: 48108
Phone: 734-214-2521
Date: 4/08/08
F10percent: Yes
F4percent: Yes
F2percent: Yes
F1percent: Yes
F0.5percent: Yes
F0.2percent: Yes
FlowExceedanceCurve: Yes
ContactAgency: Other
ContactPerson: Byron Lane
Watercourse: Flint River
LocalName:
CountyLocation: Genesee
CityorTownship: Flint
Section: 7
Town: 7N
Range: 6E
Location: The Hamilton Dam is located in downtown Flint, MI just upstream of the Saginaw Street Bridge.
uploadImage:

This reply is being sent via email only.

We have estimated the low flow discharges requested in your email of April 8, 2008 (Processes Nos.6839 to 6842), as follows:

Flint River At Hamilton Dam, SW ¼ of the SW ¼ of Section 07, T7N, R7E, Flint Township, Genesee County, has a drainage area of 748 square miles.

Danaher Creek At Danaher Lake Dam, NW ¼ of the SE ¼ of Section 18, T17N, R13W, Pleasant Plains Township, Lake County, has a drainage area of 17 square miles.

Huron River At Geddes Dam, NW ¼ of the NE ¼ of Section 36, T2S, R6E, Ann Arbor Township, Washtenaw County, has a drainage area of 775 square miles.

Huron River At Argo Dam, SW ¼ of the SW ¼ of Section 21, T2S, R6E, Ann Arbor Township, Washtenaw County, has a drainage area of 741 square miles.

The attached excel file contains the flow exceedance curves. If you have any questions, please contact Mr. Marlio Lesmez, Land and Water Management Division, Hydrologic Studies Unit, at 517-335-3173, or by e-mail at: lesmezm@michigan.gov.

Sincerely,

Richard C. Sorrell, P.E., Chief
Hydrologic Studies Unit
Land and Water Management Division
517-335-3176

RCS:MWL
cc: Mr. Marlio Lesmez, MDEQ (R-28-SW)

Argo Flow Exceedance (cfs)

Stat	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
95%	81	120	150	150	150	260	320	190	110	63	47	64	90
90%	100	150	180	170	180	330	380	240	140	86	67	78	120
85%	120	170	200	190	210	390	440	270	170	100	81	89	140
80%	130	190	220	210	230	440	480	300	190	110	94	98	160
75%	150	220	240	230	260	500	530	330	210	130	100	110	180
70%	160	240	260	260	280	560	570	360	230	140	110	120	210
65%	170	270	290	280	310	600	620	400	250	150	120	130	230
60%	180	290	310	300	330	650	670	430	270	160	130	140	260
55%	190	310	340	330	360	700	720	460	300	180	140	150	300
50%	210	330	380	350	390	740	780	500	320	190	150	160	330
45%	220	360	410	390	430	790	830	540	350	210	160	170	370
40%	240	390	440	430	470	850	880	580	380	220	170	180	420
35%	270	430	480	460	530	910	930	630	410	240	180	200	460
30%	300	470	510	500	580	990	990	690	450	270	190	220	520
25%	330	520	550	560	640	1080	1060	750	500	310	210	250	590
20%	370	560	600	630	730	1190	1140	830	550	340	240	300	670
15%	420	610	660	720	870	1320	1250	940	610	390	280	360	780
10%	490	680	730	860	1180	1500	1410	1090	730	460	340	440	940
5%	660	830	870	1110	1580	1860	1720	1410	930	580	460	580	1240

Argo

Geddes Flow Exceedance (cfs)

Stat	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
95%	96	160	180	180	180	290	350	210	160	95	78	88	110
90%	110	180	210	190	200	360	400	240	170	110	93	99	140
85%	130	200	230	200	220	410	440	270	190	130	100	110	160
80%	150	220	240	210	240	460	490	320	200	140	110	110	180
75%	170	250	270	230	260	510	560	350	220	150	120	120	200
70%	180	270	300	260	280	570	610	390	230	160	130	130	220
65%	190	300	330	280	300	620	640	420	250	170	140	140	250
60%	200	320	360	290	330	680	690	450	280	180	150	140	280
55%	210	340	390	310	350	740	740	490	300	190	160	160	310
50%	220	370	420	340	370	790	820	520	340	210	160	170	350
45%	240	400	450	370	420	850	880	570	370	220	170	170	390
40%	250	430	480	410	470	930	940	620	400	240	180	190	430
35%	280	470	510	460	530	1010	1010	670	430	260	200	210	490
30%	310	500	550	510	590	1100	1080	750	470	290	210	230	550
25%	330	530	600	560	660	1230	1170	850	520	320	220	250	620
20%	370	570	650	650	800	1330	1260	950	590	360	240	270	710
15%	420	620	720	760	980	1480	1360	1040	670	430	280	310	840
10%	480	670	850	920	1280	1690	1560	1240	780	550	380	400	1040
5%	630	770	1100	1290	1890	2160	1930	1620	1020	790	550	540	1380

Geddes

Dougherty, Dana

From: DEQ-LWM-QREQ DEQ-LWM-QREQ [DEQ-LWM-QREQ@michigan.gov]
Sent: Friday, April 18, 2008 10:32 AM
To: Dougherty, Dana
Cc: Paul Wessel
Subject: Re: flood or low flow discharge request (ContentID - 168812)

This reply is being sent via email only.

We have estimated the flood frequency discharges requested in your email of April 8, 2008 (Process No. 20080126), as follows:

Flint River at Hamilton Dam, Dam ID 60, Section 7, T07N, R07E, City of Flint, Genesee County, has a drainage area of 748 square miles. The design discharge for this dam is the 0.5% chance (200-year) flood. The 10%, 4%, 2%, 1%, and 0.5% chance peak flows are estimated to be 7200 cubic feet per second (cfs), 9000 cfs, 10300 cfs, 11800 cfs, and 13000 cfs, respectively. (Watershed Basin No. 32B Flint).

Danaher Creek at Danaher Lake Dam, Dam ID 573, Section 18, T17N, R13W, Pleasant Plains Township, Lake County, has a total drainage area of 17 square miles and a contributing drainage area of 8.4 square miles. The design discharge for this dam is the Flood of Record. The 10%, 4%, 2%, 1%, and 0.5% chance peak flows are estimated to be 90 cubic feet per second (cfs), 140 cfs, 180 cfs, 230 cfs, and 290 cfs, respectively. The Flood of Record is estimated to be 400 cfs. (Watershed Basin No. 25 Pere Marquette).

Huron River at Geddes Dam, Dam ID 561, Section 36, T02S, R06E, Ann Arbor Township, Washtenaw County, has a drainage area of 775 square miles. The design discharge for this dam is the 0.5% chance (200-year) flood. The 10%, 4%, 2%, 1%, and 0.5% chance peak flows are estimated to be 5000 cubic feet per second (cfs), 6300 cfs, 7400 cfs, 8500 cfs, and 9700 cfs, respectively. (Watershed Basin No. 15 Huron).

Huron River at Argo Dam, Dam ID 559, Section 20, T02S, R06E, City of Ann Arbor, Washtenaw County, has a drainage area of 741 square miles. The design discharge for this dam is the 0.5% chance (200-year) flood. The 10%, 4%, 2%, 1%, and 0.5% chance peak flows are estimated to be 4800 cubic feet per second (cfs), 5800 cfs, 6500 cfs, 7450 cfs, and 8500 cfs, respectively. (Watershed Basin No. 15 Huron).

Please include a copy of this letter with your inspection report or any subsequent application for permit. These estimates should be confirmed by our office if an application is not submitted within one year. If you have any questions concerning the discharge estimates, please contact Mr. Richard Sorrell, Hydrologic Studies Unit, at 517-335-3176, or by email at: sorrell@michigan.gov. If you have any questions concerning the hydraulics or the requirements for the dam safety inspection report, please contact Mr. Paul Wessel of our Dam Safety Program at 517-335-6748, or by email at: wesselpt@michigan.gov.

>>> <Dana.dougherty@stantec.com> 4/8/2008 8:22 AM >>>
Requestor: Dana M Dougherty
Company: Stantec Consulting Michigan, Inc
Address: 3959 Research Park Drive
City: Ann Arbor, MI
Zip: 48108
Phone: 734-214-2521
Date: 4/08/08
F10percent: Yes
F4percent: Yes
F2percent: Yes
F1percent: Yes
F0.5percent: Yes
F0.2percent: Yes
FlowExceedanceCurve: Yes

ContactAgency: Other
ContactPerson: Byron Lane
Watercourse: Flint River
LocalName:
CountyLocation: Genesee
CityorTownship: Flint
Section: 7
Town: 7N
Range: 6E
Location: The Hamilton Dam is located in downtown Flint, MI just upstream of the Saginaw Street Bridge.
uploadImage:

Stantec

HYDROELECTRIC REDEVELOPMENT
ARGO AND GEDDES DAMS
FEASIBILITY STUDY
CITY OF ANN ARBOR

USGS
Flow Data

science for a changing world

Water-Data Report 2007

04174500 HURON RIVER AT ANN ARBOR, MI

St. Clair-Detroit Basin
Huron Subbasin

LOCATION.--Lat 42°17'13", long 83°44'02" referenced to North American Datum of 1927, in NW ¼ sec.28, T.2 S., R.6 E., Washtenaw County, MI, Hydrologic Unit 04090005, on left bank 100 ft upstream from bridge on Maiden Lane in Ann Arbor, 0.7 mi downstream from Argo Dam, and 4.2 mi upstream from Geddes Dam.

DRAINAGE AREA.--729 mi².

SURFACE-WATER RECORDS

PERIOD OF RECORD.--February 1904 to current year. Monthly discharge only for February 1904 to September 1914 and October 1947 to July 1948, published in WSP 1307. Published as "at Geddes" February 1904 to December 1914 and as "at Barton" January 1914 to September 1940.

REVISED RECORDS.--WSP 874: 1938. WSP 2112: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 744.81 ft above sea level (levels by Michigan Department of Natural Resources). February 1904 to December 1914 at Geddes Dam, 4.2 mi downstream, and January 1914 to September 1947 at Barton Dam, 2.6 mi upstream, flow computed from records of operation of powerplants and records of depth of flow over dam and/or flow through undersluices.

REMARKS.--Records good. Prior to 1955 diversion upstream from station for Ann Arbor municipal supply had negligible effect on natural flow; annual mean discharge and runoff figures adjusted for diversion from 1955 to 1991. Flow regulated by powerplants prior to May 1962. From June 1962 to 1975 occasional regulation for lake level control operations upstream from station. Since 1975 extensive regulation of flow exists due to automation of gates at dams upstream from station. Several measurements of water temperature were made during the year. Satellite telemeter at station.

04174500 HURON RIVER AT ANN ARBOR, MI—Continued

**DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2006 TO SEPTEMBER 2007
DAILY MEAN VALUES**

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	299	489	1,200	1,150	675	824	1,220	980	290	250	125	619
2	336	458	1,430	1,190	655	827	1,200	1,110	309	235	106	593
3	381	519	1,340	1,060	557	665	1,120	977	464	223	109	374
4	389	526	1,180	1,050	395	629	1,070	867	772	211	97	392
5	369	499	1,360	1,620	315	788	975	788	924	141	129	386
6	342	511	1,290	1,780	282	781	614	738	1,040	132	124	377
7	320	546	1,250	1,670	260	783	583	653	1,020	137	154	386
8	303	578	1,150	1,820	260	734	620	635	1,050	127	157	384
9	292	590	1,070	1,760	263	727	720	739	988	118	151	390
10	294	655	791	1,640	290	888	827	738	828	111	143	383
11	286	707	784	1,550	331	1,150	795	714	732	102	143	348
12	292	710	851	1,520	426	1,160	858	684	677	91	127	303
13	294	685	960	1,540	462	1,200	869	659	625	83	126	317
14	290	682	984	1,530	481	1,350	813	634	603	79	115	345
15	286	664	937	1,780	547	1,610	770	604	474	107	110	355
16	287	711	895	1,850	521	1,640	746	592	457	61	112	355
17	514	567	874	1,650	506	1,540	688	584	449	73	109	354
18	563	718	850	1,480	493	1,460	473	563	429	74	98	341
19	533	969	830	1,390	477	1,400	528	561	424	79	189	334
20	483	838	805	1,330	438	1,340	568	508	267	81	520	316
21	493	751	793	1,310	421	1,300	576	501	263	63	679	306
22	648	678	855	1,220	437	1,300	570	374	261	62	349	509
23	601	542	909	1,160	312	1,310	494	318	243	62	458	267
24	562	544	868	1,100	308	1,260	479	320	241	33	963	170
25	538	589	716	1,040	331	1,220	515	328	227	103	598	182
26	511	580	755	945	334	1,200	595	407	197	67	609	220
27	269	559	751	819	348	1,220	730	530	308	179	655	230
28	467	544	842	812	683	1,460	838	510	273	123	609	238
29	768	527	808	785	---	1,450	759	458	275	100	613	216
30	700	643	778	782	---	1,290	715	432	264	104	654	205
31	650	---	895	718	---	1,220	---	295	---	107	649	---
Total	13,360	18,579	29,801	41,051	11,808	35,726	22,328	18,801	15,374	3,518	9,780	10,195
Mean	431	619	961	1,324	422	1,152	744	606	512	113	315	340
Max	768	969	1,430	1,850	683	1,640	1,220	1,110	1,050	250	963	619
Min	269	458	716	718	260	629	473	295	197	33	97	170

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1915 - 2007, BY WATER YEAR (WY)

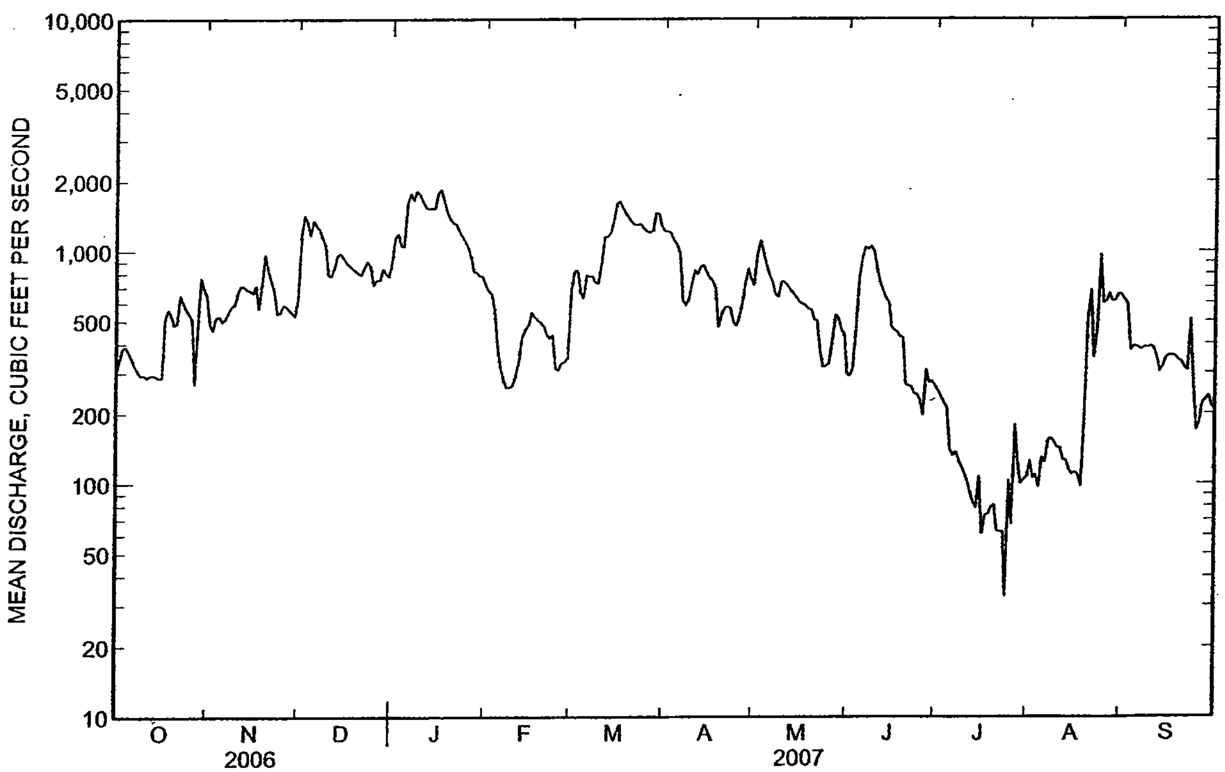
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	273	393	433	468	556	861	841	610	406	241	189	216
Max	904	1,018	1,080	1,324	1,431	2,308	2,647	2,085	1,341	1,130	689	919
(WY)	(1982)	(1993)	(1951)	(2007)	(1976)	(1918)	(1947)	(1943)	(1943)	(1968)	(2000)	(1975)
Min	71.6	109	123	131	145	189	274	187	72.0	31.5	21.1	55.8
(WY)	(1935)	(1935)	(1935)	(1925)	(1934)	(1934)	(1931)	(1925)	(1934)	(1934)	(1934)	(1934)

04174500 HURON RIVER AT ANN ARBOR, MI—Continued

SUMMARY STATISTICS

	Calendar Year 2006		Water Year 2007		Water Years 1915 - 2007	
Annual total	223,096		230,321			
Annual mean	611		631		[a]456	
Highest annual mean					824	1974
Lowest annual mean					171	1931
Highest daily mean	1,810	May 16	1,850	Jan 16	5,840	Mar 14, 1918
Lowest daily mean	60	Aug 18	33	Jul 24	[b]4.0	Aug 2, 1931[c]
Annual seven-day minimum	97	Aug 12	65	Jul 18	13	Jul 28, 1934
Maximum peak flow			2,680	Aug 24		
Maximum peak stage			15.75	Aug 24	[d]17.50	Jun 26, 1968
10 percent exceeds	1,070		1,230		933	
50 percent exceeds	570		567		338	
90 percent exceeds	176		131		120	

[a] Does not include water year 1948.
[b] Plant leakage, but doubtful due to possible change in leakage.
[c] Also occurred Sept. 11, 1931.
[d] Present site and datum.



USGS Surface-Water Monthly Statistics for Michigan

Annual Water Data Reports

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.

USGS 04174500 HURON RIVER AT ANN ARBOR, MI

Available data for this site Time-series: Monthly statistics GO

Washtenaw County, Michigan Hydrologic Unit Code 04090005 Latitude 42°17'13", Longitude 83°44'02" NAD27 Drainage area 729 square miles Gage datum 744.81 feet above sea level NGVD29	**Output formats** HTML table of all data Tab-separated data Reselect output format

00060, Discharge, cubic feet per second,	
	Monthly mean in cfs (Calculation Period: 1914-10-01 -> 2007-09-30)

YEAR	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1914										336.3	288.4	287.9
1915	348.7	1,075	717.7	403.9	367.6	384.6	352.2	454.5	731.2	526.2	399.9	383.6
1916	888.2	816.2	1,201	1,553	1,012	762.1	331.1	159.4	134.7	205.6	245.4	304.2
1917	301.4	277.7	683.0	1,025	599.9	672.8	393.0	139.6	206.0	249.4	315.3	225.5
1918	162.7	1,258	2,308	636.3	397.7	160.4	98.5	74.5	133.6	142.9	241.2	487.3
1919	342.8	274.9	976.2	1,400	994.6	330.3	192.6	160.1	161.5	227.9	358.5	338.2
1920	189.8	204.8	1,210	782.1	477.5	252.5	138.3	137.7	132.0	126.6	249.1	461.7
1921	374.1	238.9	779.4	764.3	350.9	226.7	186.2	158.9	368.6	327.1	557.0	682.2
1922	401.2	482.4	819.0	1,616	661.1	260.9	140.1	117.1	154.8	167.9	186.1	183.0
1923	200.9	188.1	823.7	457.7	336.7	166.8	124.8	93.4	125.3	137.7	167.2	321.5
1924	275.9	274.7	860.5	756.6	469.5	374.0	242.3	111.5	123.8	125.4	117.0	166.9
1925	130.6	379.1	565.9	321.7	186.8	94.6	60.4	112.1	155.3	409.8	681.9	443.7
1926	356.9	460.3	1,249	1,617	426.0	241.3	117.7	181.0	337.5	390.8	439.5	400.5
1927	275.3	692.6	697.8	427.3	395.6	403.9	212.7	107.3	146.8	208.0	278.3	788.5
1928	596.8	580.9	533.5	669.6	358.2	360.3	211.6	179.8	131.4	155.9	232.4	276.7
1929	379.3	380.2	1,126	1,098	1,086	338.1	278.7	107.5	108.6	218.1	387.1	410.1
1930	1,040	909.8	842.8	799.3	487.4	251.9	124.8	68.0	106.9	152.1	154.7	187.6
1931	166.9	226.5	299.9	274.3	226.0	201.8	71.4	42.3	56.2	79.4	154.6	187.4
1932	412.7	426.3	322.5	431.1	495.5	288.5	119.2	103.1	225.7	195.8	283.1	427.5
1933	521.7	428.6	518.1	826.0	834.4	191.5	132.9	102.9	91.8	133.5	178.4	221.2
1934	234.5	145.4	189.2	990.5	211.5	72.0	31.5	21.1	55.8	71.6	109.1	123.1
1935	201.8	216.5	680.0	317.6	408.3	319.8	151.3	142.1	98.3	105.2	267.7	246.8
1936	189.1	229.2	775.2	543.5	260.4	125.3	62.4	28.8	90.0	187.4	229.3	166.3

1937	382.7	442.0	304.7	872.7	780.5	732.6	523.7	323.7	146.5	168.7	209.5	233.9
1938	300.6	1,272	1,029	762.3	459.6	363.4	156.5	120.0	126.7	111.6	118.2	181.1
1939	213.4	609.9	875.7	1,060	394.7	299.6	141.1	84.5	78.9	132.0	151.8	149.0
1940	149.3	149.4	373.8	779.7	342.9	333.9	175.2	112.3	210.0	200.7	232.2	438.0
1941	525.1	288.8	439.3	596.5	324.8	237.5	90.1	70.7	67.5	141.0	257.3	234.8
1942	228.4	331.7	1,161	744.7	279.4	404.0	130.2	144.6	135.1	208.5	354.6	466.1
1943	645.2	891.8	1,087	621.6	2,085	1,341	377.5	248.3	283.2	244.2	432.7	246.5
1944	201.0	450.5	745.3	891.0	700.8	393.1	132.0	66.3	89.0	116.9	152.8	160.5
1945	144.8	213.6	486.9	550.7	1,225	729.8	307.0	169.8	181.6	434.8	289.8	262.8
1946	526.3	476.5	982.5	345.0	258.3	351.9	130.7	72.5	80.7	142.8	186.1	208.5
1947	285.9	251.1	643.8	2,647	1,199	871.9	301.9	292.8	585.8			
1948								198.6	209.4	204.6	411.4	424.4
1949	673.3	1,254	744.3	1,044	406.6	273.3	214.5	150.1	192.7	287.3	249.5	607.4
1950	1,257	1,167	1,637	2,231	869.2	599.4	270.0	186.5	423.2	395.5	592.0	1,080
1951	987.1	1,237	1,301	1,107	952.3	424.8	399.7	225.2	212.4	431.1	652.4	585.6
1952	1,036	892.0	1,108	1,281	704.7	396.7	188.6	166.8	187.6	203.4	329.4	444.3
1953	382.7	370.0	657.0	616.2	548.1	314.0	225.8	179.1	129.7	137.0	179.1	232.1
1954	189.4	631.0	931.8	983.9	556.5	499.5	261.6	125.3	122.4	895.4	576.9	541.2
1955	781.3	547.7	1,067	686.9	353.2	276.2	178.4	145.3	103.5	210.0	420.7	311.0
1956	205.6	248.3	1,108	828.1	1,914	581.7	266.8	409.0	244.8	170.7	248.7	366.9
1957	304.5	436.4	557.5	639.8	604.1	400.7	565.8	204.9	239.1	264.7	529.0	636.0
1958	443.2	299.4	498.3	410.1	192.1	160.1	175.3	149.7	121.3	153.9	288.6	243.5
1959	201.0	496.1	1,268	1,025	522.5	224.4	101.7	145.6	194.7	368.8	525.3	554.9
1960	724.0	714.8	558.5	1,114	582.0	507.8	298.2	177.3	135.0	171.1	278.2	199.5
1961	160.7	211.6	572.0	753.8	723.8	322.3	144.8	179.2	335.2	227.9	381.3	296.4
1962	261.6	324.6	1,092	545.3	315.6	191.3	139.7	136.6	215.5	217.9	301.3	219.7

1963	171.8	153.1	582.4	447.6	380.4	317.6	129.8	88.2	83.0	73.9	128.0	156.4
1964	173.2	179.6	260.8	361.7	368.1	192.7	137.1	94.2	105.0	90.8	153.5	195.2
1965	243.7	550.0	750.1	894.4	361.9	181.9	79.3	76.1	127.2	122.3	234.9	447.5
1966	362.2	297.5	491.5	383.6	529.1	188.5	146.5	105.5	98.2	102.1	268.0	460.5
1967	346.0	418.1	788.9	851.0	364.3	344.5	256.7	134.6	125.9	282.2	451.8	649.9
1968	476.2	1,038	601.8	784.0	657.9	1,148	1,130	569.2	377.4	332.5	516.9	683.2
1969	875.3	774.6	573.2	1,156	1,098	885.8	740.5	345.3	169.4	268.1	418.4	396.4
1970	302.5	333.0	683.8	898.1	615.0	422.7	351.2	178.0	182.3	393.5	553.0	532.8
1971	312.6	998.3	985.7	582.0	285.8	173.6	94.0	52.7	104.0	160.3	200.2	315.2
1972	392.8	243.1	568.1	657.9	570.9	198.7	213.5	200.0	270.3	283.0	601.9	641.0
1973	978.7	565.8	1,355	1,015	756.7	706.2	525.9	444.0	207.9	324.1	574.9	743.4
1974	1,110	1,118	1,966	1,635	1,199	575.1	252.5	239.1	168.8	213.4	377.0	382.9
1975	671.6	721.5	885.1	1,081	605.1	398.5	238.2	293.3	918.8	397.1	512.4	875.3
1976	503.5	1,431	1,867	968.1	1,136	413.9	337.0	150.5	139.1	240.3	331.6	243.3
1977	192.0	275.3	769.4	836.2	383.9	230.8	193.6	118.8	170.9	219.1	344.4	500.3
1978	330.0	316.2	861.5	966.3	594.9	273.1	149.3	98.4	103.7	169.6	289.7	314.6
1979	293.6	206.7	760.0	914.6	533.4	238.9	369.4	254.8	116.9	164.6	387.2	504.4
1980	456.8	288.6	702.8	1,179	632.8	614.8	216.5	437.9	562.5	409.2	405.5	514.5
1981	318.4	910.8	699.8	752.2	702.3	421.9	191.3	162.2	537.5	903.6	667.5	473.7
1982	430.5	397.9	1,654	1,216	441.3	509.5	365.0	172.0	154.3	172.8	584.0	636.8
1983	395.9	418.3	626.9	1,076	1,178	526.0	233.0	186.7	129.4	184.5	439.2	598.3
1984	312.5	576.3	772.3	756.7	711.6	383.6	116.6	100.8	136.8	217.5	430.0	381.6
1985	610.4	708.2	1,556	1,165	420.0	371.4	222.5	230.1	275.4	409.4	772.5	643.0
1986	487.0	742.1	1,355	711.2	454.7	490.8	377.2	181.4	360.0	848.6	502.1	626.0
1987	455.2	397.5	608.0	480.5	227.3	175.6	145.0	185.1	247.4	242.5	492.1	820.5
1988	533.6	600.2	750.0	839.5	270.2	73.1	62.9	153.0	215.0	320.6	863.7	487.0

1989	511.3	380.5	502.1	673.7	378.0	1,045	406.4	167.3	337.9	240.1	560.5	361.5
1990	643.1	923.8	1,423	996.4	784.4	411.0	205.0	186.6	377.4	825.5	778.0	818.3
1991	951.4	733.1	802.1	815.8	577.9	368.5	132.4	186.7	127.9	264.2	493.9	569.5
1992	479.5	509.8	703.2	805.8	565.3	275.2	353.9	416.5	547.3	543.1	1,018	683.9
1993	1,243	618.9	932.4	1,255	621.5	719.8	446.7	229.0	441.8	518.6	487.6	421.7
1994	343.3	601.4	970.5	694.7	537.1	304.9	412.5	381.3	248.9	391.0	652.4	686.1
1995	689.0	457.3	911.1	770.0	627.2	362.7	378.8	583.8	171.0	266.6	713.6	460.7
1996	399.4	413.5	618.2	648.3	962.5	818.5	285.4	138.5	188.0	263.1	564.7	618.4
1997	601.2	861.1	1,203	909.7	839.4	543.8	336.8	332.8	457.8	396.5	623.9	522.7
1998	879.8	1,058	1,308	1,028	668.5	308.1	208.3	220.3	152.2	167.5	313.4	297.3
1999	425.8	556.7	482.1	683.4	411.6	168.5	234.1	155.6	101.4	130.6	236.9	293.5
2000	256.6	241.2	315.1	359.7	574.7	639.9	538.6	688.8	571.9	496.2	498.2	479.8
2001	445.8	1,335	1,032	674.9	693.1	673.5	153.3	155.2	203.8	901.9	722.3	802.6
2002	480.2	809.8	928.6	704.8	598.0	322.9	110.1	115.2	89.1	132.9	271.6	217.3
2003	186.7	158.7	398.5	512.2	531.1	338.9	107.0	103.4	152.6	187.3	437.8	387.8
2004	381.4	290.1	765.1	324.4	971.2	774.7	396.0	396.4	174.8	151.5	452.0	618.4
2005	1,100	961.4	931.2	576.6	361.2	171.1	176.6	144.6	141.1	140.6	338.9	357.0
2006	741.4	871.6	913.9	757.0	986.5	383.4	231.0	156.4	294.4	431.0	619.3	961.3
2007	1,324	421.7	1,152	744.3	606.5	512.5	113.5	315.5	339.8			
Mean of monthly Discharge	468	557	861	841	610	406	241	189	216	273	393	433

** No Incomplete data have been used for statistical calculation

Title: Surface Water data for Michigan: USGS Surface-Water Monthly Statistics
URL: http://waterdata.usgs.gov/mi/nwis/monthly?

APPENDIX B
Manufacturer Quotes

Canadian Hydro Components, Ltd.

CANADIAN HYDRO COMPONENTS LTD.

BUDGET PRICE

DATE: 09 June 2008 **BP #2008-146**

TURBINE DATA

Project Name	**Argo-Option 1**	**Argo – Option 2**
Rated Net Head	3.048 m	3.627 m
Turbine Type	Axial Flow Pit Double Regulated (4 blade)	Axial Flow Pit Double Regulated (4 blade)
Runner Diameter	1700 mm	1700 mm
Flow/Unit max	15.576 cms	17.275 cms
Turbine Speed	200 rpm	220 rpm
Generator Speed	720 rpm	720 rpm
Turbine Shaft Output/unit	415 kW	546 kW
Generator Output/unit	387 kW	508 kW
Turbine Setting	2.64 m above TWL	1.16 m above TWL
Number of Units	1	1
Total Output	387 kW	508 kW

BUDGET PRICE

OPTION-1	**OPTION-2**
1-Runner/Distributor Assembly	1-Runner/Distributor Assembly
1-Draft Tube Liner	1-Draft Tube Liner
1-Gear Box	1-Gear Box
1-Synchronous Generator	1-Synchronous Generator
1-Hydraulic Power Unit	1-Hydraulic Power Unit
1-Switchgear/Control/Protection	1-Switchgear/Control/Protection

TOTAL ABOVE PACKAGE PRICE: $ 1,185,000 USD [Option-1]

TOTAL ABOVE PACKAGE PRICE: $ 1,185,000 USD [Option-2]

PAYMENT SCHEDULE

Deposit	25 % with order
Progress Payment Due Mid-Contract	45 %
Due Before Shipment	20 %
At successful start-up No later than 120 days after shipment	10 %

ALL PRICES QUOTED ARE IN USD DOLLARS, FOB ALMONTE, ONTARIO, SUBJECT TO ALL APPLICABLE TAXES AND DUTIES AND MAY CHANGE AFTER 90 DAYS.

P.O. Box 640 – 16 Main Street Almonte, Ontario CANADA K0A 1A0
Tel: (613) 256-1983 Fax: (613) 256-4235 Email: inquiries@canadianhydro.com

CANADIAN HYDRO COMPONENTS LTD.

BUDGET PRICE

DATE: 09 June 2008 **BP #2008-147**

TURBINE DATA

Project Name	**Geddes**
Rated Net Head	4.343 m
Turbine Type	Axial Flow Pit Double Regulated (4 blade)
Runner Diameter	1700 mm
Flow/Unit max	18.408 cms
Turbine Speed	240 rpm
Generator Speed	720 rpm
Turbine Shaft Output/unit	700 kW
Generator Output/unit	652 kW
Turbine Setting	0.06 m below TWL
Number of Units	1
Total Output	652 kW

BUDGET PRICE

1-Runner/Distributor Assembly
1-Draft Tube Liner
1-Gear Box
1-Synchronous Generator
1-Hydraulic Power Unit
1-Switchgear/Control/Protection

TOTAL ABOVE PACKAGE PRICE: $ 1,185,000 USD

PAYMENT SCHEDULE

Deposit	25 % with order
Progress Payment Due Mid-Contract	45 %
Due Before Shipment	20 %
At successful start-up No later than 120 days after shipment	10 %

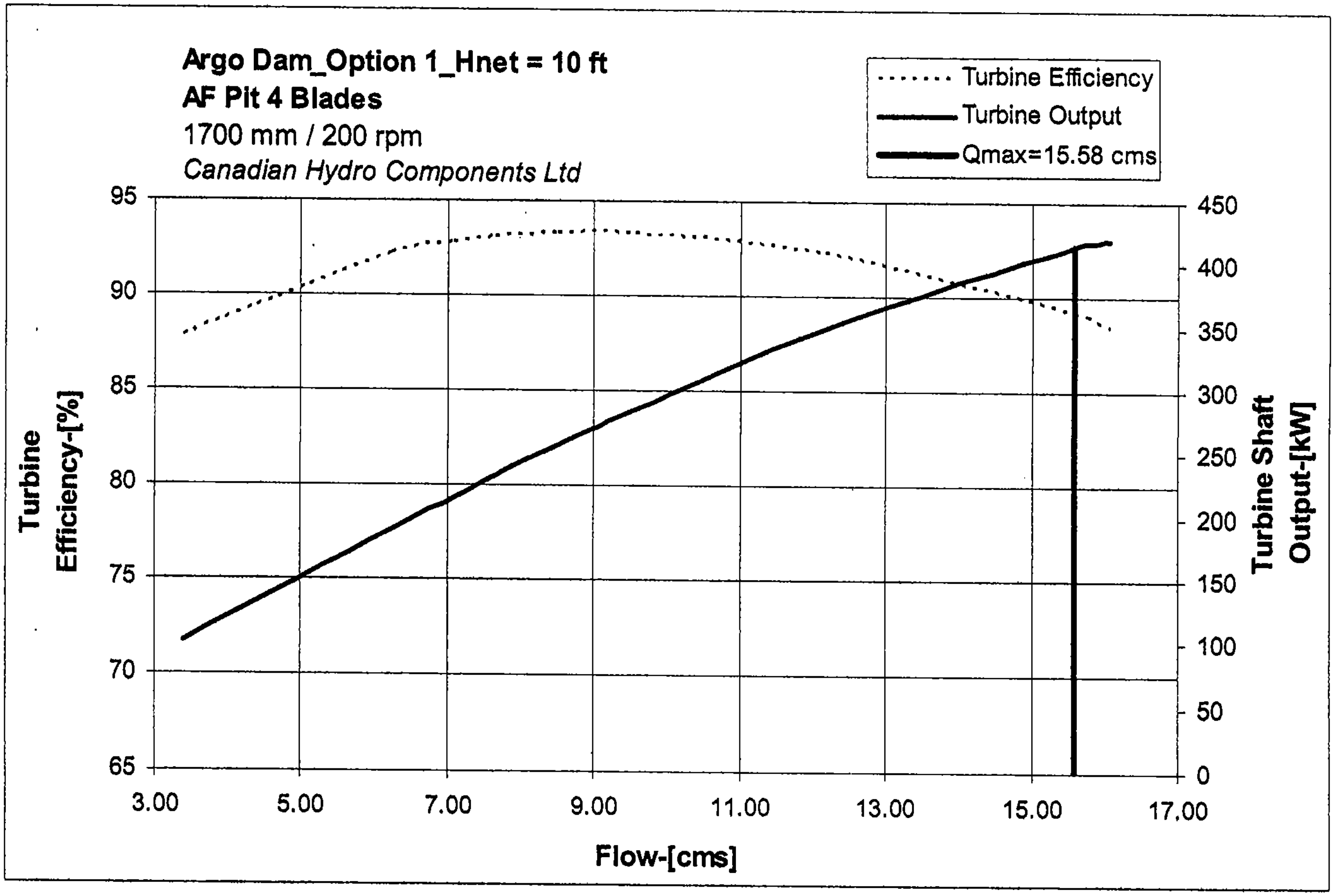
ALL PRICES QUOTED ARE IN USD DOLLARS, FOB ALMONTE, ONTARIO, SUBJECT TO ALL APPLICABLE TAXES AND DUTIES AND MAY CHANGE AFTER 90 DAYS.

P.O. Box 640 – 16 Main Street Almonte, Ontario CANADA K0A 1A0
Tel: (613) 256-1983 Fax: (613) 256-4235 Email: inquiries@canadianhydro.com

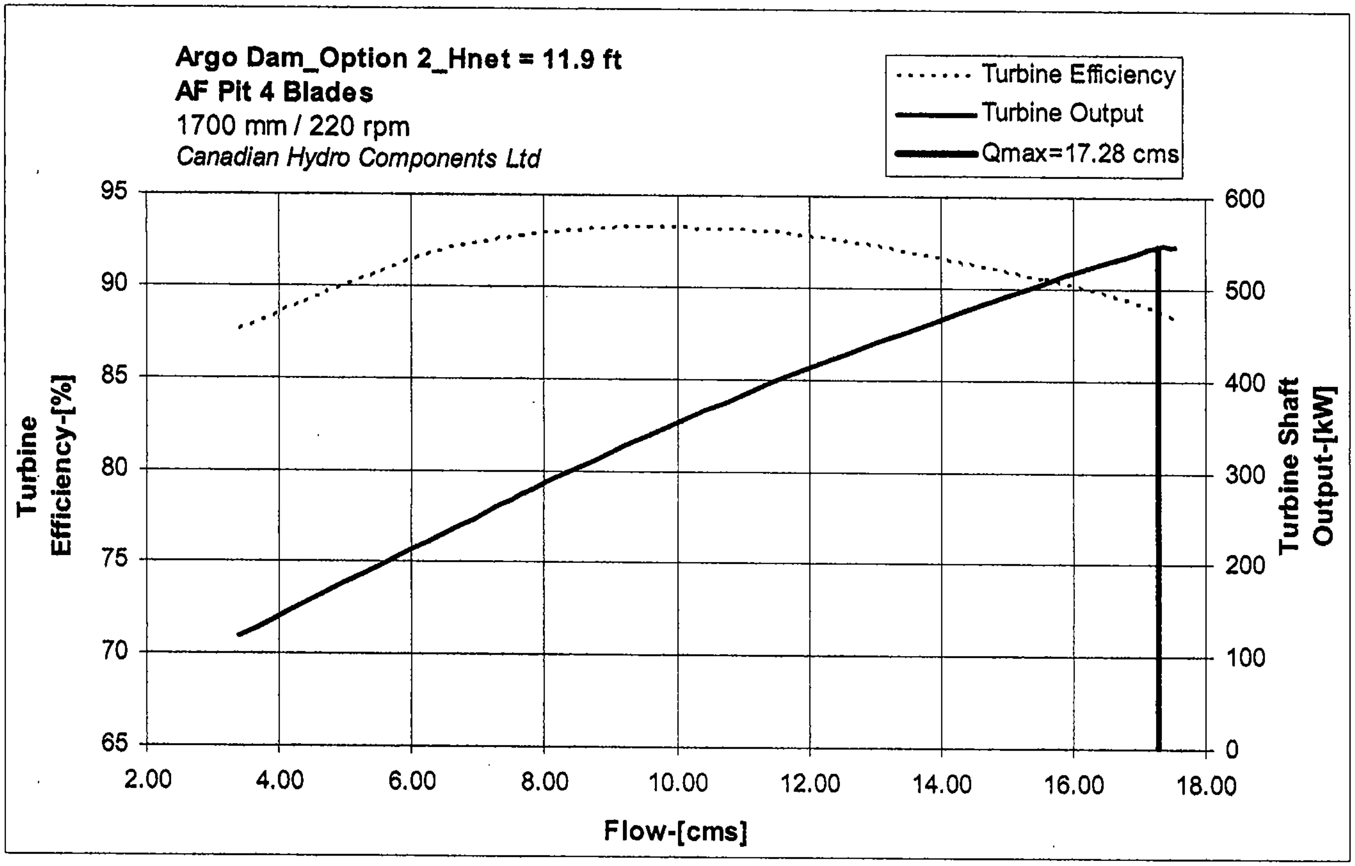
Date:	June 4 2008			
Project:	Huron Rive_Argo Dam & Geddes Dam			
Ref	Email from Stantec with Flow Duration Tables and Drawings			
	Babette's email dated June 2 2008			
		Argo Option 1	Argo Option 2	Geddes
Hnet	ft	10.00	11.90	14.25
	m	3.048	3.627	4.343
Flow	cfs	550	610	650
	cms	15.576	17.275	18.408
No of units		1	1	1
Potential Pgen	kW	394	521	664
		1 X 1700 mm	1 X 1700 mm	1 X 1700 mm
Proposal		G.Box Drive	G.Box Drive	G.Box Drive
Turbine Type		AF Pit	AF Pit	AF Pit
Straight Flow Turbine		I-0deg,O-0deg	I-0deg,O-0deg	I-0deg,O-0deg
		DR	DR	DR
Loss Coeff: inlet, outlet, Sc. Up		0, 0, 0.8	0, 0, 0.8	0, 0, 0.8
Model		4 blade	4 blade	4 blade
Hnet	m	3.048	3.627	4.343
Runner Dia.	m	1.700	1.700	1.700
n-Turbine Speed	rpm	200	220	240
n11	rpm	194.75	196.38	195.77
Q/unit	cms	15.576	17.275	18.408
Total Flow	cms	15.576	17.275	18.408
Q11	cms	3.087	3.139	3.056
Turbine Efficiency	%	89.20	88.80	89.30
Turbine Output-Perf Curve	kW	415	546	700
Gear Box Efficiency	%	98	98	98
Generator Efficiency	%	95	95	95
Gen. Output/unit	kW	387	508	652
Generator Speed	rpm	720	720	720
Gen to Turb Speed Ratio		3.6	3.3	3.0
(Hb-Hv)-local Elev&Temp	m	10	10	10
Sigma Calculated		2.171	2.236	2.141
Sigma from Curve		2.250	2.300	2.200
Margin on setting	m	0.5	0.5	0.5
Turbine Setting-permissible	m	2.64	1.16	-0.06
No. of Units		1	1	1
Total Output	kW	387	508	652

Notes:

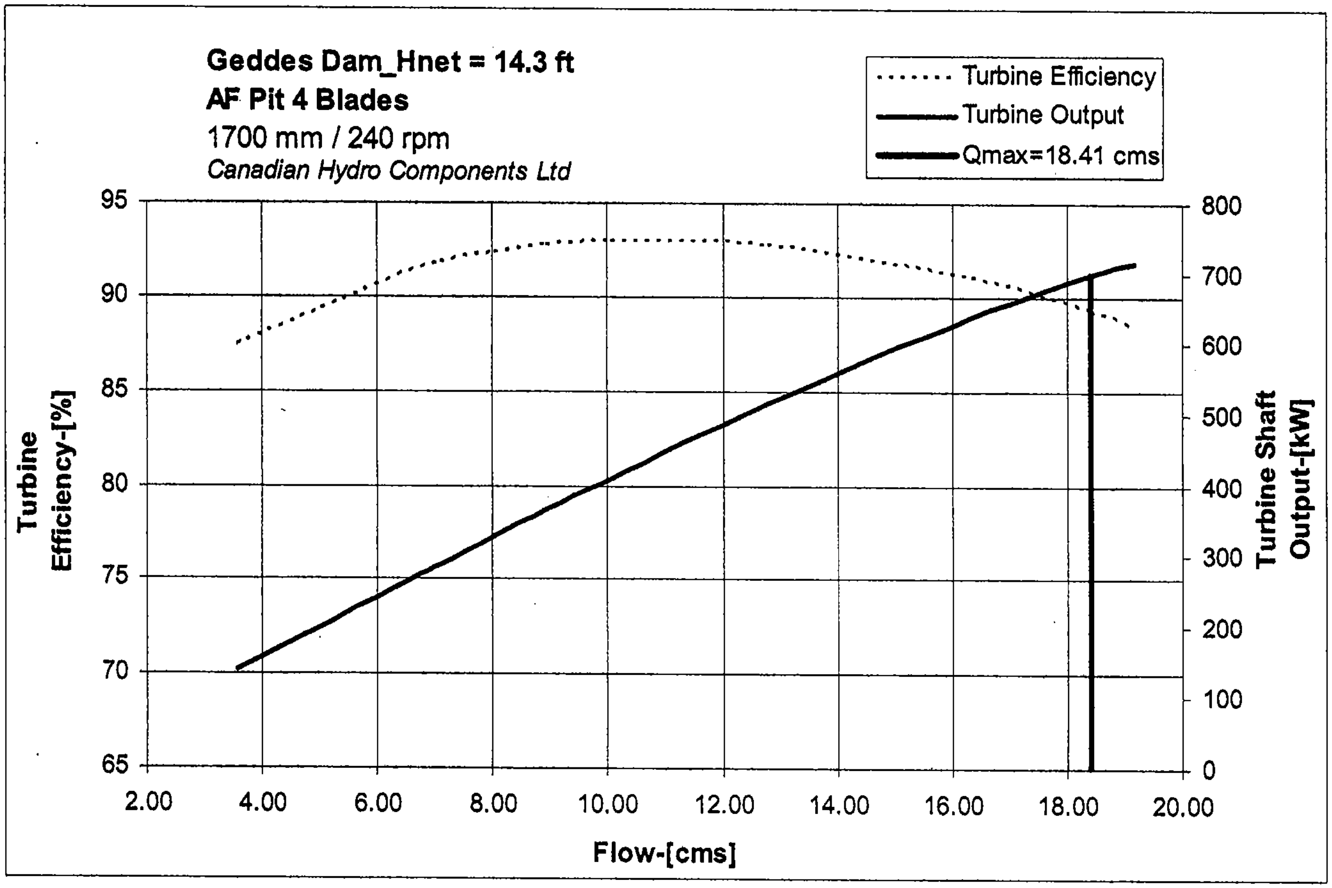
1. To select the same size for each option, Argo Dam Option 1 is sized for 30% flow exceedance; Argo Dam Option 2 and Geddes Dam are sized for 25% exceedance.
2. The net head has to match with the design turbine flow rate, see in the Flow Duration Curves.
3. K504-4 model curve, with wide open blade angle=36 deg requires a n11min = 180 rpm for Q11=3.14 cms
4. We need to keep suitable margin for Q11 at rated point, therefore the n11 min recommended is 190 rpm.
5. Herman's graph "Bulb Turbine statistics" for Project Devinefoss [Hn=5.85 m] is designed with n11=197 rpm and Q11=3.05 cms.



Argo Dam_Option 1_Hnet = 10 ft
AF Pit 4 Blades
1700 mm / 200 rpm
Canadian Hydro Components Ltd
Turbine Efficiency
Turbine Output
Qmax=15.58 cms
Turbine Efficiency-[%]
95
90
85
80
75
70
65
3.00
5.00
7.00
9.00
11.00
13.00
15.00
17.00
Flow-[cms]
450
400
350
300
250
200
150
100
50
0
Turbine Shaft Output-[kW]

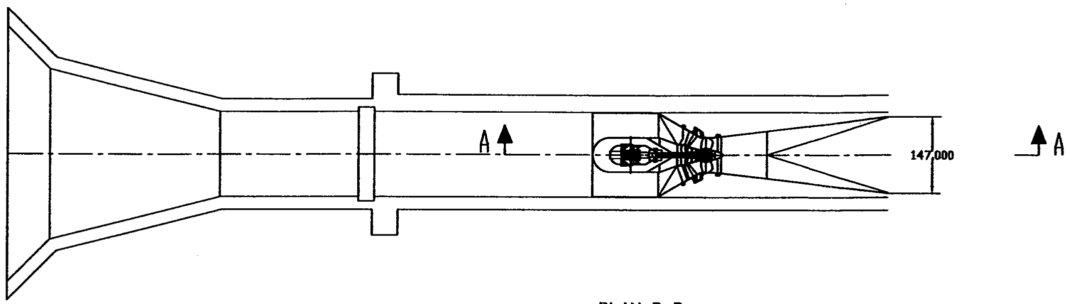


Argo Dam_Option 2_Hnet = 11.9 ft
AF Pit 4 Blades
1700 mm / 220 rpm
Canadian Hydro Components Ltd
Turbine Efficiency
Turbine Output
Qmax=17.28 cms
Turbine Efficiency-[%]
95
90
85
80
75
70
65
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
Flow-[cms]
600
500
400
300
200
100
0
Turbine Shaft Output-[kW]

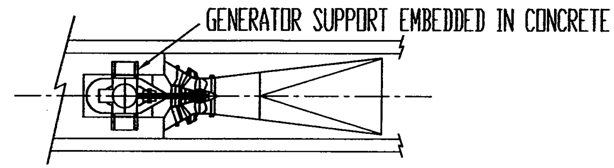

Geddes Dam_Hnet = 14.3 ft
AF Pit 4 Blades
1700 mm / 240 rpm
Canadian Hydro Components Ltd
Turbine Efficiency
Turbine Output
Qmax=18.41 cms
Turbine Efficiency-[%]
95
90
85
80
75
70
65
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow-[cms]
800
700
600
500
400
300
200
100
0
Turbine Shaft Output-[kW]

NOTES:

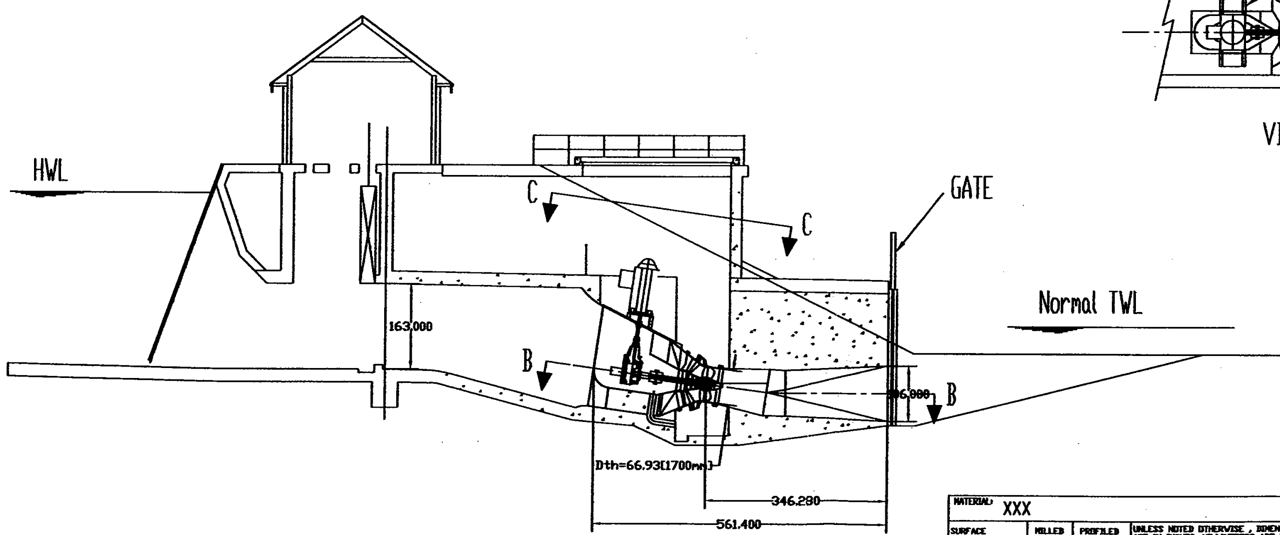
1. ALL DIMENSIONS ARE IN INCHES UNLESS STATED OTHERWISE.
2. GENERATOR OUTLINE IS INDICATIVE ONLY AND WILL BE REVISED ON RECEIPT OF MANUFACTURER'S DRAWING.
3. THIS IS A TYPICAL GENERAL ARRANGMENT FOR AN AF PIT TURBINE, SUBJECT TO CHANGES FOR THE SPECIFIC SITE.



PLAN B-B



VIEW C-C



SECTION A-A

REV	DESCRIPTION	ENG. BY:	DATE
C	REVISED		
B	REVISED		
A	ORIGINAL ISSUE		

MATERIAL: XXX

SURFACE FINISH: MILLED 125, PROFILED 63

DRAWN BY: DATE:

ENG. BY: XXX DATE: XX/XX/XX

CHECKED BY: DATE:

THIRD ANGLE PROJECTION

WELDING STANDARD: CSA W59

UNLESS NOTED OTHERWISE, DIMENSIONS ARE IN INCHES, MILLIMETERS ARE IN SQUARE BRACKETS, AND TOLERANCES APPLY AS SHOWN BELOW. REMOVE ALL BURRS & SHARP EDGES.

INCHES — BASIC DIMENSION — DECIMAL PLACES: FRACTIONS ±1/32, .XX ±.01, .XXX ±.005

MILLIMETERS — BASIC DIMENSION — DECIMAL PLACES: .XX ±.25, .XX ±.10

ANGULAR DIMENSIONS — BASIC DIMENSION — ALL ANGLES: X ±2.0°, XX ±0.5°

CANADIAN HYDRO COMPONENTS LTD.
16 MAIN STREET
ALMONTE, ONTARIO
CANADA K0A 1A0
PHONE#: (613) 256-1983
EMAIL#: INQUIRES@CANADIANHYDRO.COM
FAX#: (613) 256-4235

DESC. GENERAL ARRANGEMENT FOR AF PIT

PART NO. REV. C

PROJECT NAME: SIZE: B SHEET: 1 OF: 1 SCALE:

CANADIAN
HYDRO
COMPONENTS LTD.

BUDGET PRICE

DATE: 09 June 2008 **BP #2008-146**

TURBINE DATA

Project Name	**Argo-Option 1**	**Argo – Option 2**
Rated Net Head	3.048 m	3.627 m
Turbine Type	Axial Flow Pit Double Regulated (4 blade)	Axial Flow Pit Double Regulated (4 blade)
Runner Diameter	1700 mm	1700 mm
Flow/Unit max	15.576 cms	17.275 cms
Turbine Speed	200 rpm	220 rpm
Generator Speed	720 rpm	720 rpm
Turbine Shaft Output/unit	415 kW	546 kW
Generator Output/unit	387 kW	508 kW
Turbine Setting	2.64 m above TWL	1.16 m above TWL
Number of Units	1	1
Total Output	387 kW	508 kW

BUDGET PRICE

OPTION-1	**OPTION-2**
1-Runner/Distributor Assembly	1-Runner/Distributor Assembly
1-Draft Tube Liner	1-Draft Tube Liner
1-Gear Box	1-Gear Box
1-Synchronous Generator	1-Synchronous Generator
1-Hydraulic Power Unit	1-Hydraulic Power Unit
1-Switchgear/Control/Protection	1-Switchgear/Control/Protection

TOTAL ABOVE PACKAGE PRICE: $ 1,185,000 USD [Option-1]

TOTAL ABOVE PACKAGE PRICE: $ 1,185,000 USD [Option-2]

PAYMENT SCHEDULE

Deposit	25 % with order
Progress Payment Due Mid-Contract	45 %
Due Before Shipment	20 %
At successful start-up No later than 120 days after shipment	10 %

ALL PRICES QUOTED ARE IN USD DOLLARS, FOB ALMONTE, ONTARIO, SUBJECT TO ALL APPLICABLE TAXES AND DUTIES AND MAY CHANGE AFTER 90 DAYS.

P.O. Box 640 – 16 Main Street Almonte, Ontario CANADA K0A 1A0
Tel: (613) 256-1983 Fax: (613) 256-4235 Email: inquiries@canadianhydro.com

CANADIAN HYDRO COMPONENTS LTD.

BUDGET PRICE

DATE: 09 June 2008 **BP #2008-147**

TURBINE DATA

Project Name	**Geddes**
Rated Net Head	4.343 m
Turbine Type	Axial Flow Pit Double Regulated (4 blade)
Runner Diameter	1700 mm
Flow/Unit max	18.408 cms
Turbine Speed	240 rpm
Generator Speed	720 rpm
Turbine Shaft Output/unit	700 kW
Generator Output/unit	652 kW
Turbine Setting	0.06 m below TWL
Number of Units	1
Total Output	652 kW

BUDGET PRICE

1-Runner/Distributor Assembly
1-Draft Tube Liner
1-Gear Box
1-Synchronous Generator
1-Hydraulic Power Unit
1-Switchgear/Control/Protection

TOTAL ABOVE PACKAGE PRICE: $ 1,185,000 USD

PAYMENT SCHEDULE

Deposit	25 % with order
Progress Payment Due Mid-Contract	45 %
Due Before Shipment	20 %
At successful start-up No later than 120 days after shipment	10 %

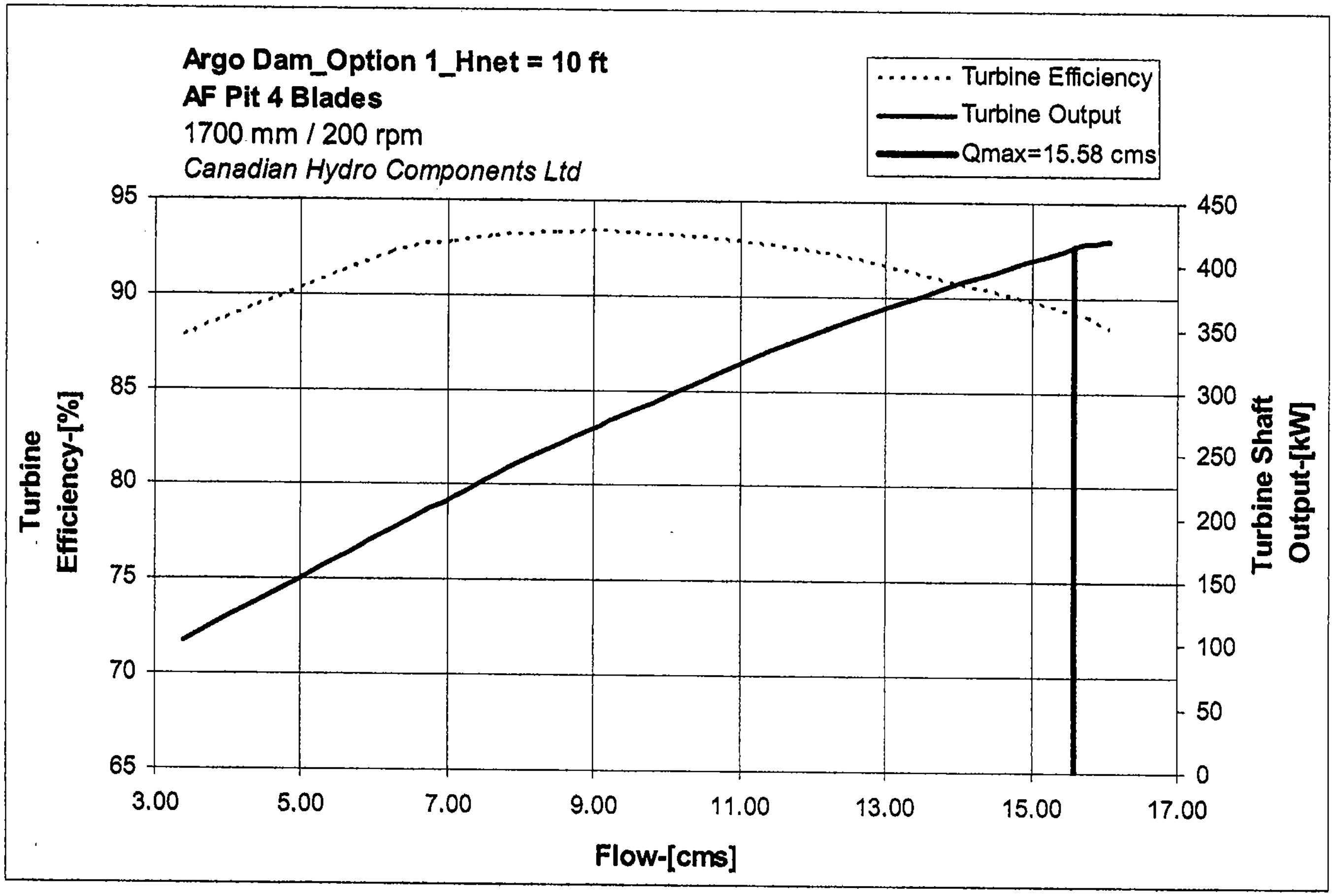
ALL PRICES QUOTED ARE IN USD DOLLARS, FOB ALMONTE, ONTARIO, SUBJECT TO ALL APPLICABLE TAXES AND DUTIES AND MAY CHANGE AFTER 90 DAYS.

P.O. Box 640 – 16 Main Street Almonte, Ontario CANADA K0A 1A0
Tel: (613) 256-1983 Fax: (613) 256-4235 Email: inquiries@canadianhydro.com

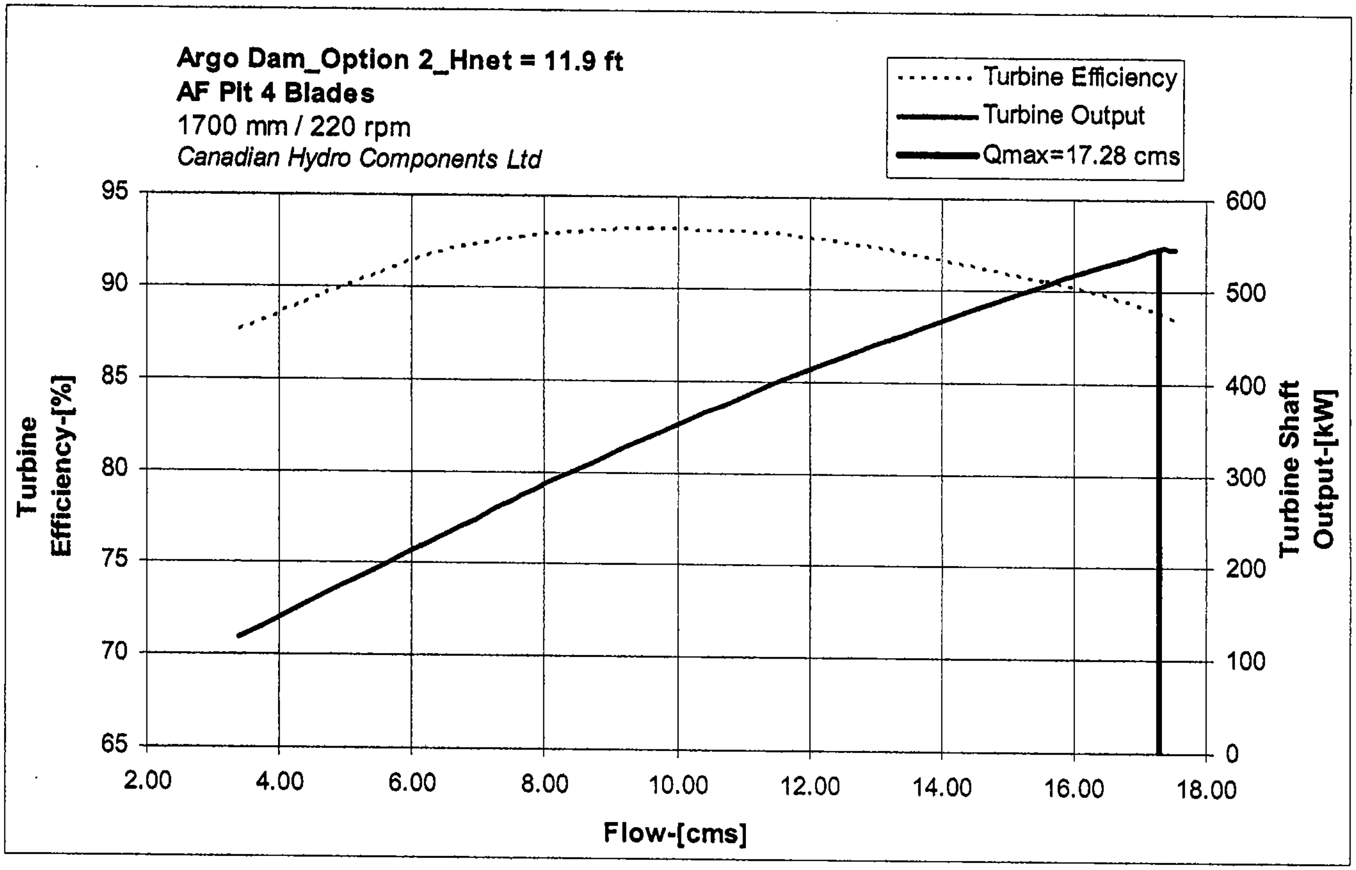
Date:	June 4 2008			
Project:	Huron Rive_Argo Dam & Geddes Dam			
Ref	Email from Stantec with Flow Duration Tables and Drawings			
	Babette's email dated June 2 2008			
		Argo Option 1	**Argo Option 2**	**Geddes**
Hnet	ft	**10.00**	**11.90**	**14.25**
	m	3.048	3.627	4.343
Flow	cfs	**550**	**610**	**650**
	cms	15.576	17.275	18.408
No of units		1	1	1
Potential Pgen	kW	394	521	664
		1 X 1700 mm	**1 X 1700 mm**	**1 X 1700 mm**
Proposal		**G.Box Drive**	**G.Box Drive**	**G.Box Drive**
Turbine Type		**AF Pit**	**AF Pit**	**AF Pit**
Straight Flow Turbine		**I-0deg,O-0deg**	**I-0deg,O-0deg**	**I-0deg,O-0deg**
		DR	**DR**	**DR**
Loss Coeff: inlet, outlet, Sc. Up		**0, 0, 0.8**	**0, 0, 0.8**	**0, 0, 0.8**
Model		**4 blade**	**4 blade**	**4 blade**
Hnet	m	**3.048**	**3.627**	**4.343**
Runner Dia.	m	**1.700**	**1.700**	**1.700**
n-Turbine Speed	rpm	**200**	**220**	**240**
n11	rpm	194.75	196.38	195.77
Q/unit	cms	**15.576**	**17.275**	**18.408**
Total Flow	cms	**15.576**	**17.275**	**18.408**
Q11	cms	3.087	3.139	3.056
Turbine Efficiency	%	**89.20**	**88.80**	**89.30**
Turbine Output-Perf Curve	kW	415	546	700
Gear Box Efficiency	%	98	98	98
Generator Efficiency	%	**95**	**95**	**95**
Gen. Output/unit	kW	387	508	652
Generator Speed	rpm	**720**	**720**	**720**
Gen to Turb Speed Ratio		3.6	3.3	3.0
(Hb-Hv)-local Elev&Temp	m	**10**	**10**	**10**
Sigma Calculated		2.171	2.236	2.141
Sigma from Curve		**2.250**	**2.300**	**2.200**
Margin on setting	m	0.5	0.5	0.5
Turbine Setting-permissible	m	2.64	1.16	-0.06
No. of Units		**1**	**1**	**1**
Total Output	kW	387	508	652

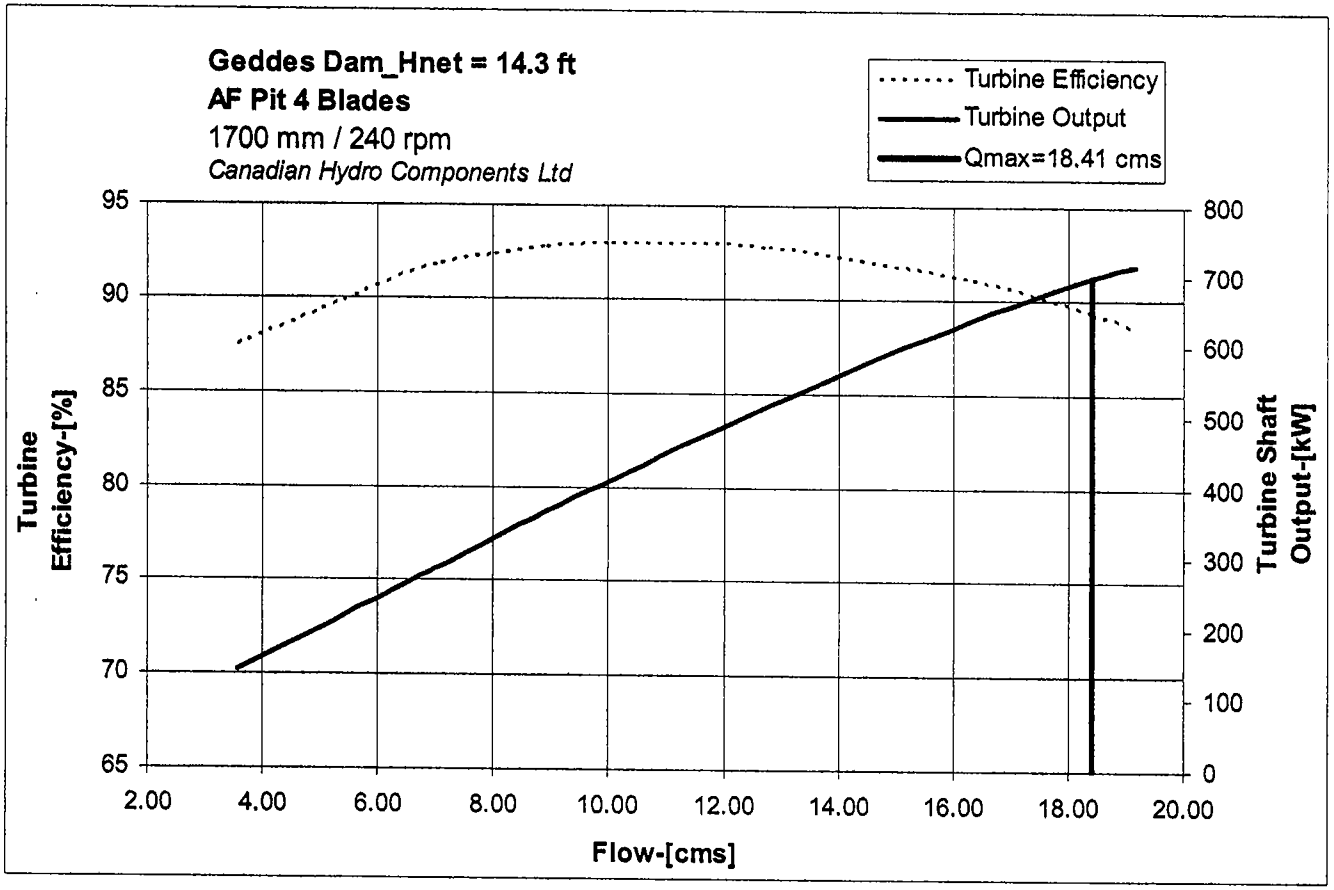
Notes:

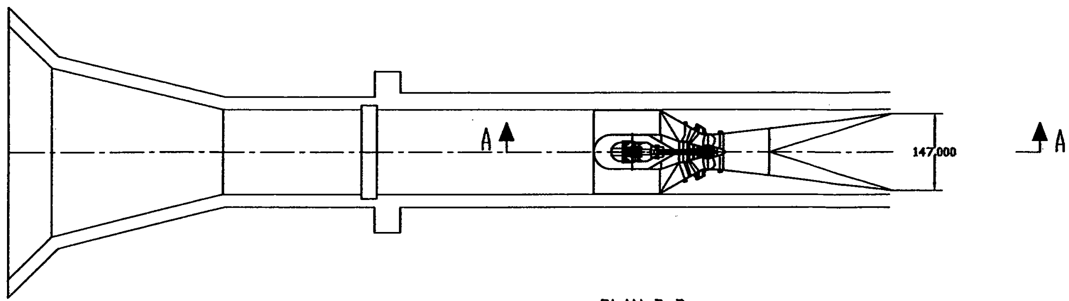
1. **To select the same size for each option, Argo Dam Option 1 is sized for 30% flow exceedance; Argo Dam Option 2 and Geddes Dam are sized for 25% exceedance.**
2. **The net head has to match with the design turbine flow rate, see in the Flow Duration Curves.**
3. **K504-4 model curve, with wide open blade angle=36 deg requires a n11min = 180 rpm for Q11=3.14 cms**
4. **We need to keep suitable margin for Q11 at rated point, therefore the n11 min recommended is 190 rpm.**
5. **Herman's graph "Bulb Turbine statistics" for Project Devinefoss [Hn=5.85 m] is designed with n11=197 rpm and Q11=3.05 cms.**



Argo Dam_Option 1_Hnet = 10 ft
AF Pit 4 Blades
1700 mm / 200 rpm
Canadian Hydro Components Ltd
Turbine Efficiency
Turbine Output
Qmax=15.58 cms
Turbine Efficiency-[%]
95
90
85
80
75
70
65
3.00
5.00
7.00
9.00
11.00
13.00
15.00
17.00
Flow-[cms]
Turbine Shaft Output-[kW]
450
400
350
300
250
200
150
100
50
0


Argo Dam_Option 2_Hnet = 11.9 ft
AF Plt 4 Blades
1700 mm / 220 rpm
Canadian Hydro Components Ltd
Turbine Efficiency
Turbine Output
Qmax=17.28 cms
Turbine Efficiency-[%]
95
90
85
80
75
70
65
Turbine Shaft Output-[kW]
600
500
400
300
200
100
0
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
Flow-[cms]

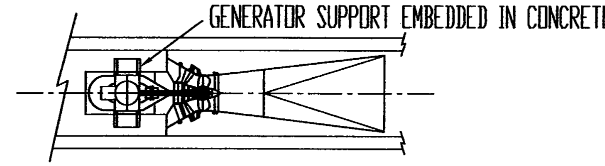

Geddes Dam_Hnet = 14.3 ft
AF Pit 4 Blades
1700 mm / 240 rpm
Canadian Hydro Components Ltd
Turbine Efficiency
Turbine Output
Qmax=18.41 cms
Turbine Efficiency-[%]
95
90
85
80
75
70
65
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow-[cms]
800
700
600
500
400
300
200
100
0
Turbine Shaft Output-[kW]



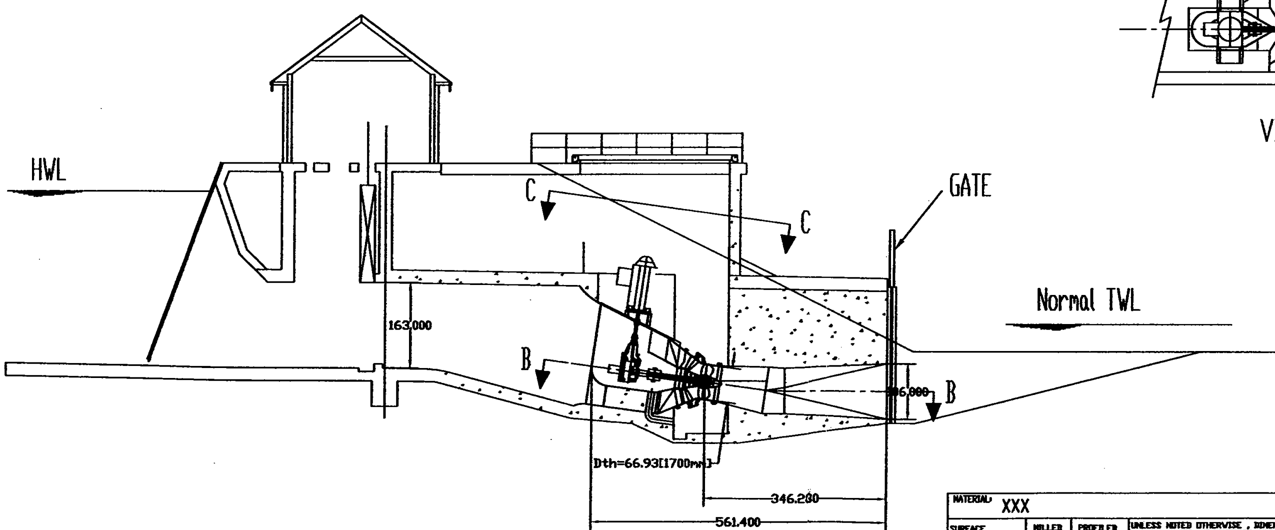
PLAN B-B

NOTES:

1. ALL DIMENSIONS ARE IN INCHES UNLESS STATED OTHERWISE.
2. GENERATOR OUTLINE IS INDICATIVE ONLY AND WILL BE REVISED ON RECEIPT OF MANUFACTURER'S DRAWING.
3. THIS IS A TYPICAL GENERAL ARRANGMENT FOR AN AF PIT TURBINE, SUBJECT TO CHANGES FOR THE SPECIFIC SITE.



VIEW C-C



SECTION A-A

REV	DESCRIPTION	ENG. BY:	DATE
C	REVISED		
B	REVISED		
A	ORIGINAL ISSUE		

MATERIAL: XXX

SURFACE FINISH	MILLED	PROFILED
	125	63

DRAWN BY:	DATE:
ENG. BY: XXX	DATE: XX/XX/XX
CHECKED BY:	DATE:

THIRD ANGLE PROJECTION:

WELDING STANDARD: CSA W59

UNLESS NOTED OTHERWISE, DIMENSIONS ARE IN INCHES, MILLIMETERS ARE IN SQUARE BRACKETS, AND TOLERANCES APPLY AS SHOWN BELOW.REMOVE ALL BURRS & SHARP EDGES.

INCHES

BASIC DIMENSION	DECIMAL PLACES		
	FRACTIONS	.XX	.XXX
	±1/32	±.01	±.005

MILLIMETERS

BASIC DIMENSION	DECIMAL PLACES	
	.XX	.XX
	±.25	±.10

ANGULAR DIMENSIONS

BASIC DIMENSION	X	X.X
ALL ANGLES	±2.0°	±0.5°

CANADIAN HYDRO COMPONENTS LTD.
16 MAIN STREET
ALMONTE, ONTARIO
CANADA K0A 1A0
PHONE#: (613) 256-1983
EMAIL#: INQUIRES@CANADIANHYDRO.COM
FAX#: (613) 256-4235

DESC. GENERAL ARRANGEMENT FOR AF PIT

PART NO.

REV. C

PROJECT NAME:	SIZE: B	SHEET: 1 OF: 1	SCALE:

HTS, Inc.
(Ossberger)

Dougherty, Dana

From: Alfred Patzig [hts-inc@hts-inc.com]
Sent: Monday, May 05, 2008 7:57 PM
To: Dougherty, Dana
Subject: GEDDES DAM
Attachments: Est. of Energy Production - Contractor.xls; 2331AD4-178c2.pdf; 2331AD4-178e1.pdf; 2331AD4-178e2.pdf; AD4GenDescript.pdf

Dana -

in reference to our telephone conversation on April 21st regarding suitable hydro equipment for the two Ann Arbor Dam Projects, I have attached our estimates and graphs with general data on the Bulb Turbine equipment proposed. Please refer also to the Kaplan Turbine Brochure S-158 under Model A to get an idea of the setup.

Depending on the height of the turbine setting above tailwater, you can expect full flow range generation, as shown on the graph sheets.

In accordance with your flow duration curve, I have inserted preliminary, unconfirmed efficiency values for the different head and flow scenario

I hope this is sufficient information for your study - let me know, if you have further questions at this point.

Sincerely
Alfred F. Patzig, Eng.
President
HYDROPOWER TURBINE SYSTEMS, INC. (HTS-INC)
PO Box 736
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May 5, 2008

Mr. Dana Dougherty
STANTEC
Ann Arbor, MI

COST ESTIMATE

SUBJECT: **KAPLAN BULB TURBINE Type AD4**
PROJECT: **GEDDES DAM – OPTION 1 – grid parallel**
REF NO: **P-2331-1**

In accordance with OSSBERGER's standard Terms and Conditions of Sale and Delivery we propose one Kaplan Model A Bulb inclined Turbine, including generator, precision flat belt speed increaser and turbine regulator (automatic water level controller) for the above referenced hydro project, having the following data:

Rated Net head	4.3 m (= 14.1 ft)
Flow range	3.3 – 19.7 cms (= 116 – 696 cfs)
Runner diameter	1780 mm (= 70 ins)
Speed nominal	186/726 rpm
Model	HSI AD4-178
Turbine Output	724 kW max
Generator rating	725 kW, 480V/3/60, 10-pole, RTD's
Note	Refer to Turbine graph and general description in the enclosure.

Scope of Supply:
(1) Kaplan Turbine inclined, 4-bladed, double regulated, excluding elbow draft tube liner
(1) Digital water level regulator - Type: OSSBERGER DR-10
(1) Induction Generator - Type: HITZINGER AGS 9-10T vertical
(1) Speed increaser – precision flat belt with pulleys
(1) Switchgear w/ circuit breaker, generator protection relays and display – optional (not included)

Budget Price: **EUROS 490,000**

CIP: Port of Export Germany (per INCOTERMS 2000)
Exchange rate currently 1.60 USD
Packing/Crating included
Freight/Importation: est. USD 50,000
Installation: excluded
Payment: 50% down, balance prior to shipping
Terms: Std. Terms and Conditions of Sale and Delivery S-143e
Delivery: approx. 15 months

HYDROPOWER TURBINE SYSTEMS, INC. (HTS-INC)

Enclosure: Turbine graph 2331AD4-178c2
General description AD4, Brochure S-158

PERFORMANCE DATA for OSSBERGER KAPLAN TURBINE

BULB TURBINE **HSI AD4 - 178** **Model A**

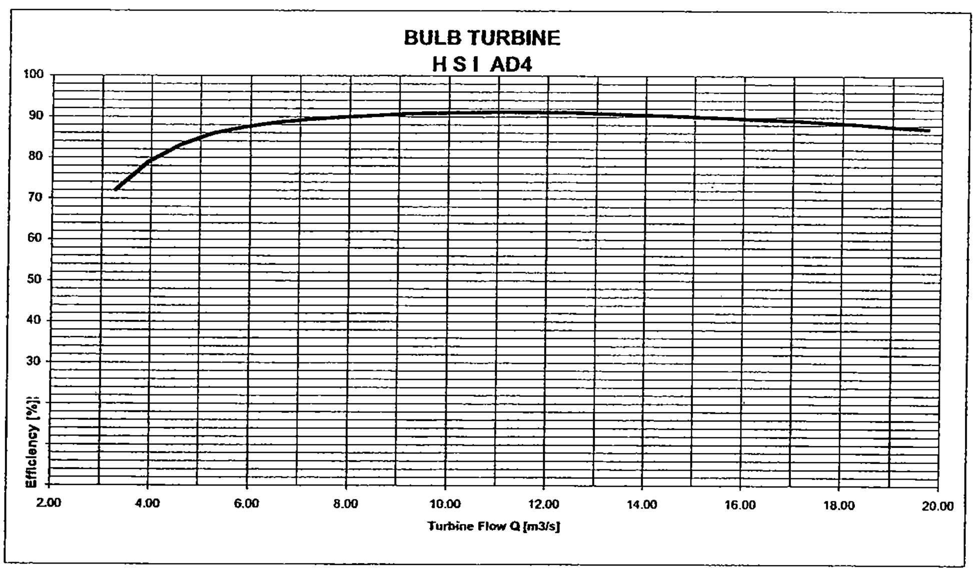
Nethead [ft] = 14.11
Nethead [m] = 4.30 n [rpm] = 186 n_{11} = 160
D [m] = 1.78
Elevation [mMSL] 100

DETA [%]

at Q_{11} = 2,6 2.09

P [kW]	Q [m³/s]	ETA [%]	HS zul [m]	Q [cfs]	
724.12	19.71	87.09	0.96	695.99	
704.00	19.05	87.59	1.43	672.79	
684.38	18.40	88.19	1.95	649.59	
662.93	17.74	88.59	2.38	626.39	
641.98	17.08	89.09	2.81	603.19	GUARANTEED
618.68	16.43	89.29	3.20	579.99	GUARANTEED
596.59	15.77	89.69	3.54	556.79	GUARANTEED
573.64	15.11	89.99	3.89	533.59	GUARANTEED
550.53	14.45	90.29	4.23	510.39	GUARANTEED
526.67	13.80	90.49	4.53	487.19	GUARANTEED
503.25	13.14	90.79	4.83	463.99	GUARANTEED
479.15	12.48	90.99	5.18	440.79	GUARANTEED
454.43	11.83	91.09	5.43	417.59	GUARANTEED
429.18	11.17	91.09	5.73	394.39	GUARANTEED
403.49	10.51	90.99	5.95	371.19	GUARANTEED
377.86	9.86	90.89	6.16	347.99	GUARANTEED
351.89	9.20	90.69	6.25	324.79	GUARANTEED
325.31	8.54	90.29	6.25	301.60	GUARANTEED
298.96	7.88	89.89	6.25	278.40	GUARANTEED
272.52	7.23	89.39	6.25	255.20	GUARANTEED
245.53	6.57	88.59	6.25	232.00	GUARANTEED
218.23	5.91	87.49	6.25	208.80	GUARANTEED
190.44	5.26	85.89	6.25	185.60	GUARANTEED
161.20	4.60	83.09	6.25	162.40	GUARANTEED
131.19	3.94	78.89	6.25	139.20	GUARANTEED
99.90	3.29	72.09	6.25	116.00	

EXPECTED



Legend: P.... mechanical output at turbine shaft
Q ... Flow in m3/sec or cfs
HS ... max. runner setting above tailwaterlevel (based on project elevation - mMSL indicated)

Note: Performance data guaranteed stipulate ideal flow intake and outlet conditions
Performance data outside guaranteed area is expected only

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May 5, 2008

Mr. Dana Dougherty
STANTEC
Ann Arbor, MI

COST ESTIMATE

SUBJECT: **KAPLAN BULB TURBINE Type AD4**
PROJECT: **ARGO DAM – OPTION 1**
REF NO: **P-2330-1**

In accordance with OSSBERGER's standard Terms and Conditions of Sale and Delivery we propose one Kaplan Model A Bulb inclined Turbine, including generator, precision flat belt speed increaser and turbine regulator (automatic water level controller) for the above referenced hydro project, having the following data:

Rated Net head	3.0 m (= 9.8 ft)
Flow range	3.5 – 20.8 cms (= 122 – 733 cfs)
Runner diameter	2000 mm (= 79 ins)
Speed nominal	139/910 rpm
Model	HSI AD4-200
Turbine Output	532 kW max
Generator rating	525 kW, 480V/3/60, 8-pole, RTD's
Note	Refer to Turbine graph and general description in the enclosure.

Scope of Supply:
(1) Kaplan Turbine inclined, 4-bladed, double regulated, excluding elbow draft tube liner
(1) Digital water level regulator - Type: OSSBERGER DR-10
(1) Induction Generator - Type: HITZINGER AGS 7-08T vertical
(1) Speed increaser – precision flat belt with pulleys
(1) Switchgear w/ circuit breaker, generator protection relays and display – optional (not included)

Budget Price: **EUROS 470,000**

CIP:	Port of Export Germany (per INCOTERMS 2000) Exchange rate currently 1.60 USD
Packing/Crating	included
Freight/Importation:	est. USD 45,000
Installation:	excluded
Payment:	50% down, balance prior to shipping
Terms:	Std. Terms and Conditions of Sale and Delivery S-143e
Delivery:	approx. 15 months

HYDROPOWER TURBINE SYSTEMS, INC. (HTS-INC)

Enclosure: Turbine graph 2330AD4-200c2
General description AD4, Brochure S-158

PERFORMANCE DATA for OSSBERGER KAPLAN TURBINE

BULB TURBINE — HSI AD4 - 178 — Model A

Nethead [ft] =	11.81
Nethead [m] =	3.60
D [m] =	1.78
Elevation [mMSL]	100

n [rpm] = 171

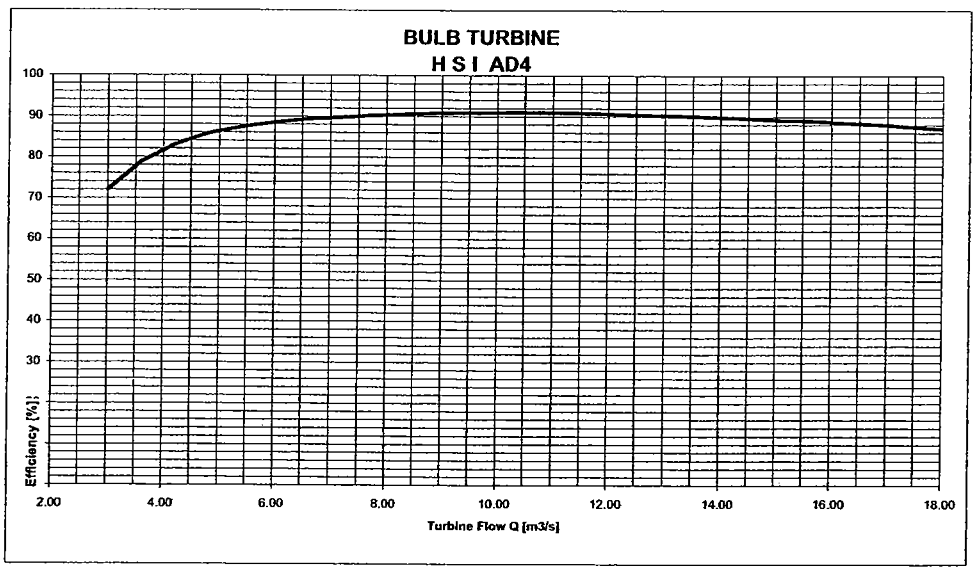
n_{11} = 160

DETA	[%]
at Q_{11} = 2,6	1.97

P [kW]	Q [m³/s]	ETA [%]	HS_{zul} [m]	Q [cfs]
553.90	18.03	86.97	2.38	636.82
538.52	17.43	87.47	2.78	615.60
523.52	16.83	88.07	3.21	594.37
507.11	16.23	88.47	3.57	573.14
491.09	15.63	88.97	3.93	551.91
473.26	15.03	89.17	4.25	530.69
456.37	14.43	89.57	4.54	509.46
438.82	13.83	89.87	4.83	488.23
421.14	13.23	90.17	5.12	467.00
402.89	12.62	90.37	5.37	445.78
384.98	12.02	90.67	5.62	424.55
366.54	11.42	90.87	5.91	403.32
347.63	10.82	90.97	6.13	382.09
328.32	10.22	90.97	6.38	360.87
308.66	9.62	90.87	6.56	339.64
289.05	9.02	90.77	6.74	318.41
269.19	8.42	90.57	6.81	297.18
248.86	7.82	90.17	6.81	275.96
228.69	7.21	89.77	6.81	254.73
208.47	6.61	89.27	6.81	233.50
187.82	6.01	88.47	6.81	212.27
166.94	5.41	87.37	6.81	191.05
145.67	4.81	85.77	6.81	169.82
123.30	4.21	82.97	6.81	148.59
100.34	3.61	78.77	6.81	127.36
76.39	3.01	71.97	6.81	106.14

GUARANTEED (rows 491.09 to 100.34)

EXPECTED



Legend: P.... mechanical output at turbine shaft
Q ... Flow in m3/sec or cfs
HS ... max. runner setting above tailwaterlevel (based on project elevation - mMSL indicated)

Note: Performance data guaranteed stipulate ideal flow intake and outlet conditions
Performance data outside guaranteed area is expected only

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May 5, 2008

Mr. Dana Dougherty
STANTEC
Ann Arbor, MI

COST ESTIMATE

SUBJECT: KAPLAN BULB TURBINE Type AD4
PROJECT: ARGO DAM – OPTION 2
REF NO: P-2330-2

In accordance with OSSBERGER's standard Terms and Conditions of Sale and Delivery we propose one Kaplan Model A Bulb inclined Turbine, including generator, precision flat belt speed increaser and turbine regulator (automatic water level controller) for the above referenced hydro project, having the following data:

Rated Net head	3.6 m (= 11.8 ft)
Flow range	3.0 – 18.0 cms (= 106 – 636 cfs)
Runner diameter	1780 mm (= 70 ins)
Speed nominal	171/910 rpm
Model	HSI AD4-178
Turbine Output	553 kW max
Generator rating	550 kW, 480V/3/60, 8-pole, RTD's
Note	Refer to Turbine graph and general description in the enclosure.

Scope of Supply:
(1) Kaplan Turbine inclined, 4-bladed, double regulated, excluding elbow draft tube liner
(1) Digital water level regulator - Type: OSSBERGER DR-10
(1) Induction Generator - Type: HITZINGER AGS 7-08T vertical
(1) Speed increaser – precision flat belt with pulleys
(1) Switchgear w/ circuit breaker, generator protection relays and display – optional (not included)

Budget Price: EUROS 465,000

CIP: Port of Export Germany (per INCOTERMS 2000)
Exchange rate currently 1.60 USD
Packing/Crating included
Freight/Importation: est. USD 45,000
Installation: excluded
Payment: 50% down, balance prior to shipping
Terms: Std. Terms and Conditions of Sale and Delivery S-143e
Delivery: approx. 15 months

HYDROPOWER TURBINE SYSTEMS, INC. (HTS-INC)

Enclosure: Turbine graph 2330AD4-178c2
General description AD4, Brochure S-158

PERFORMANCE DATA for OSSBERGER KAPLAN TURBINE

BULB TURBINE — HSI AD4 - 200 — Model A

Nethead [ft] = 9.84
Nethead [m] = 3.00
D [m] = 2.00
Elevation [mMSL] 100

n [rpm] = 139

n_{11} = 160

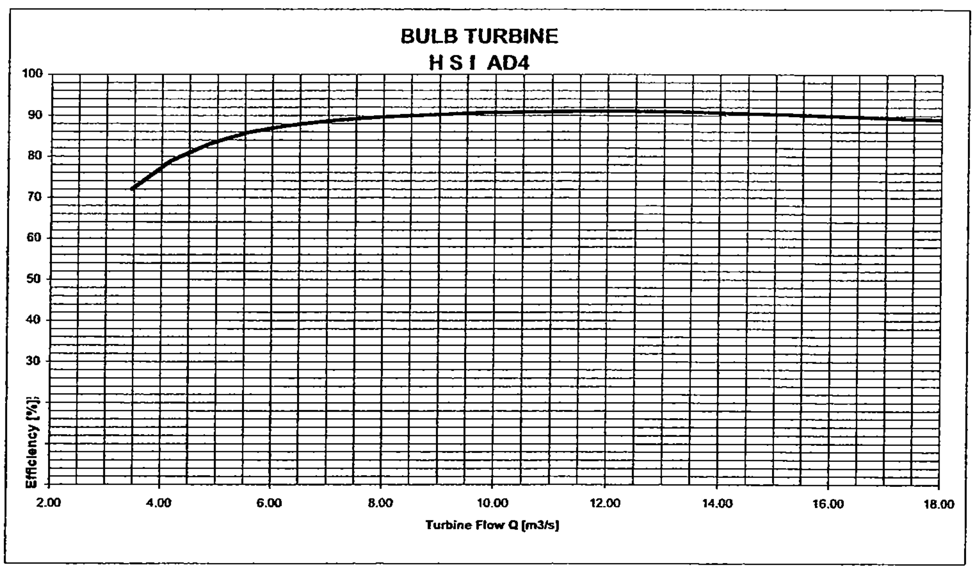
DETA [%]

at Q_{11} = 2,6 — 2.00

P [kW]	Q [m³/s]	ETA [%]	HS zul [m]	Q [cfs]
532.18	20.78	87.00	3.60	733.92
517.40	20.09	87.50	3.93	709.46
502.99	19.40	88.10	4.29	684.99
487.22	18.71	88.50	4.59	660.53
471.83	18.01	89.00	4.89	636.06
454.70	17.32	89.20	5.16	611.60
438.47	16.63	89.60	5.40	587.14
421.61	15.93	89.90	5.64	562.67
404.62	15.24	90.20	5.88	538.21
387.09	14.55	90.40	6.09	513.74
369.88	13.86	90.70	6.30	489.28
352.16	13.16	90.90	6.54	464.82
333.99	12.47	91.00	6.72	440.35
315.44	11.78	91.00	6.93	415.89
296.56	11.09	90.90	7.08	391.42
277.71	10.39	90.80	7.23	366.96
258.63	9.70	90.60	7.29	342.50
239.10	9.01	90.20	7.29	318.03
219.72	8.31	89.80	7.29	293.57
200.29	7.62	89.30	7.29	269.10
180.45	6.93	88.50	7.29	244.64
160.39	6.24	87.40	7.29	220.18
139.96	5.54	85.80	7.29	195.71
118.47	4.85	83.00	7.29	171.25
96.41	4.16	78.80	7.29	146.78
73.41	3.46	72.00	7.29	122.32

GUARANTEED (boxed rows 471.83 – 96.41)

EXPECTED



Legend: P.... mechanical output at turbine shaft
Q ... Flow in m3/sec or cfs
HS ... max. runner setting above tailwaterlevel (based on project elevation - mMSL indicated)

Note: Performance data guaranteed stipulate ideal flow intake and outlet conditions
Performance data outside guaranteed area is expected only

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May 5, 2008

Mr. Dana Dougherty
STANTEC
Ann Arbor, MI

COST ESTIMATE

SUBJECT: **KAPLAN BULB TURBINE Type AD4**
PROJECT: **ARGO DAM – OPTION 2 – stand-alone**
REF NO: **P-2331-2**

In accordance with OSSBERGER's standard Terms and Conditions of Sale and Delivery we propose one Kaplan Model A Bulb inclined Turbine, including generator, precision flat belt speed increaser, fly-wheel and speed governor (for stand-alone operation) for the above referenced hydro project, having the following data:

Rated Net head	4.3 m (= 14.1 ft)
Flow range	3.3 – 19.7 cms (= 116 – 696 cfs)
Runner diameter	1780 mm (= 70 ins)
Speed nominal	186/720 rpm
Model	HSI AD4-178
Turbine Output	724 kW max
Generator rating	850 kVA, 480V/3/60, 10-pole, RTD's
Note	Refer to Turbine graph and general description in the enclosure.

Scope of Supply:
(1) Kaplan Turbine inclined, 4-bladed, double regulated, excluding elbow draft tube liner
(1) Digital speed governor - Type: OSSBERGER S-2MK/R
(1) Synchronous Generator - Type: HITZINGER SGS 9-10T vertical
(1) Speed increaser – precision flat belt with pulleys
(1) Flywheel – mass 1.5 MT
(1) Switchgear w/ circuit breaker, generator protection relays and display – optional (not included)

Budget Price: **EUROS 550,000**

CIP: Port of Export Germany (per INCOTERMS 2000)
Exchange rate currently 1.60 USD
Packing/Crating included
Freight/Importation: est. USD 55,000
Installation: excluded
Payment: 50% down, balance prior to shipping
Terms: Std. Terms and Conditions of Sale and Delivery S-143e
Delivery: approx. 15 months

HYDROPOWER TURBINE SYSTEMS, INC. (HTS-INC)

Enclosure: Turbine graph 2331AD4-178c2
General description AD4, Brochure S-158

OSSBERGER KAPLAN TURBINE PROGRAM

DOUBLE REGULATED INCLINED TUBULAR KAPLAN TURBINE
TYPE AD4

GENERAL DESCRIPTION

Compact and flexible arrangement of generating unit and powerhouse, developed by our company within the last 20 years for mini hydro stations in the low head range between approx. 1 to 8m and power output range between approx. 0.1 to 1.5 MW.

High specific speed and discharge as well as high turbine performance are obtained by an optimized hydraulic design of turbine housing, wicket gates, turbine runner and draft tube.

Power transmission between turbine and generator is provided by precision flat belt drive which is arranged for easy accessibility and replacement in a dry cylindrical pit (belt pit) made of plate steel. This arrangement enables quick and easy access to the whole belt drive and turbine bearings for inspection and maintenance without requirement of draining the turbine housing.

The turbine housing consists of reinforced concrete, partially prefabricated with steel liner. The belt pit forms part of the turbine housing. The rectangular inlet duct of the turbine housing and the water flow through the turbine is split by the belt pit and upstream pier nose.

Depending on local conditions, the cross section of the upstream water conduit from the intake to the turbine may be either rectangular or circular.

The turbine runner (up to 2.24 m DIA) is provided with 4 adjustable runner blades. The movable wicket gates of the conical distributor are controlled by the turbine governor system for adjustment of turbine flow, regulation of headwater level and for turbine shut-off. The turbine shaft axis may be arranged horizontally or slightly inclined (up to approx. 12 degrees against horizontal plane).

SCOPE OF SUPPLY

The Turbine includes stationary and moving components, such as belt pulley, dismantling piece for draft tube, complete operating mechanism for control of runner blades and wicket gates including the servomotors (oil-hydraulic cylinders). The steel liner of turbine housing and draft tube cone are optional.

Technical documentation, including:

- Turbine installation drawing with all required dimensions and loadings to foundations and anchoring structures.
- Instruction manuals for operation and maintenance.
- Turbine performance chart.
- Declaration of EG-conformity.

COMPONENT DESCRIPTION

TURBINE SHAFT
Hollow shaft made of forged carbon steel with incorporated blade control rod, properly sealed. For torque transmission and fixing of turbine runner and belt pulley on the shaft only tapered friction-locking elements (no wedges) are used, enabling quick assembly and disassembly even after long operation periods.

SHAFT BEARINGS
Maintenance-free spherical roller bearings with grease lubrication, performed by automatically controlled centralized lubrication device.

SHAFT SEAL
Maintenance-free, reinforced flexible rings, sealing radially on replaceable shaft protection sleeve, made of stainless steel and provided with wear-resistent ceramic coat. Automatic lubrication by controlled lubrication device.

TURBINE RUNNER
Four automatically controlled, adjustable blades, made of wear- and cavitation resistent bronce CuAl10Fe5Ni5-C. The blade discs are double sealed against the hub and the blade stems supported in maintenance-free slide bearings.
The hub is made of cast iron GGG40 and the hub-to-shaft connection designed as friction-locking type as mentioned for the shaft.

RUNNER CONTROL
The opening position of all blades is synchronized and controlled by a cross head arranged in the hub and by the control rod rotating with the shaft and moving axially when changing the blade opening position. The control rod is supported at the upper end of the turbine shaft by an adjustable bearing sleeve. The rotating upper end of the control rod is connected to a double acting axial roller bearing whose non-rotating housing is moved axially by the runner servomotor (oil hydraulic cylinder). The linear potentiometer for measuring and transmitting the blade opening position is arranged parallel to and fixed on the servomotor.

DISCHARGE RING
Welded construction, made of carbon steel RSt 52, machined cylindrically with small tolerance. Flanges sealed by o-rings against distributor cone upstream and against dismantling piece downstream. Due to the provision of the dismantling piece downstream, no longitudinal split of the discharge ring is required and complicated double joints between longitudinal and circumferential flange seals are avoided.

DISMANTLING PIECE
The conical dismantling piece, made of carbon steel RSt 52, arranged downstream of the discharge ring, is provided with an amply sized manhole and with telescopic flange connection to the draft tube steel liner.

DISTRIBUTOR
Outer and inner distributor cones are made of cast iron GG25. Surfaces adjacent to the wicket gates are machined cylindrically with small tolerances, enabling small gaps between cones and wicket gates. Wicket gates are made of cast iron GGG40 and provided with maintenance-free, self-lubricating, sealed stem bearings on both ends. The seals of the stem bearings arranged on the water side to protect the bearing surfaces against wear caused by abrasive particles in the water. The stem bearing seals may be replaced without dismantling the wicket gate.

DISTRIBUTOR CONTROL
Is provided by a double-acting oil-hydraulic servomotor. Opening position of the distributor is measured and transmitted by rotational potentiometer arranged on one of the wicket gate stems. For emergency closing a dead weight is provided, acting on the gate ring.

TURBINE HOUSING
comprised of reinforced concrete, which can partially be made of prefabricated components, depending on local conditions and transport facilities, can be procured locally by others. Steel liners with anchor rings and loops are optional and designed as lost formwork of the housing in the embedded conical part upstream of the outer distributor cone and inside the central part of the housing (belt pit). The non-embedded outer distributor cone is bolted to the upstream steel liner of the conical transition to the rectangular inlet duct which is split by the belt pit and the pier nose.

BELT PULLEY
The belt pulley (material RSt 52) for the flat belt is of welded construction, heat treated for stress relief before machining and statically balancing. The outer surface of the pulley is machined with shape and smoothness according to the requirements of the belt manufacturer.

DRAFT TUBE
consisting of the embedded conical steel liner downstream of the dismantling piece and the transition part between cone and rectangular outlet section. The transition part may be constructed with complete steel lining or with formwork made of wood, depending on the local facilities.

ANTICORROSIVE PROTECTION
All turbine components made of steel (except those made of stainless steel) are completely sandblasted and provided with two base coats and two top coats of a high quality product of the one-pack poliurethane type. Colour -as far as not otherwise agreed- green (RAL 6011) for embedded and non-moving turbine components, yellow for moving main components (belt pulley, gate regulating ring). Small components of distributor (levers, links) galvanized.

HYDROPOWER TURBINE SYSTEMS, INC.
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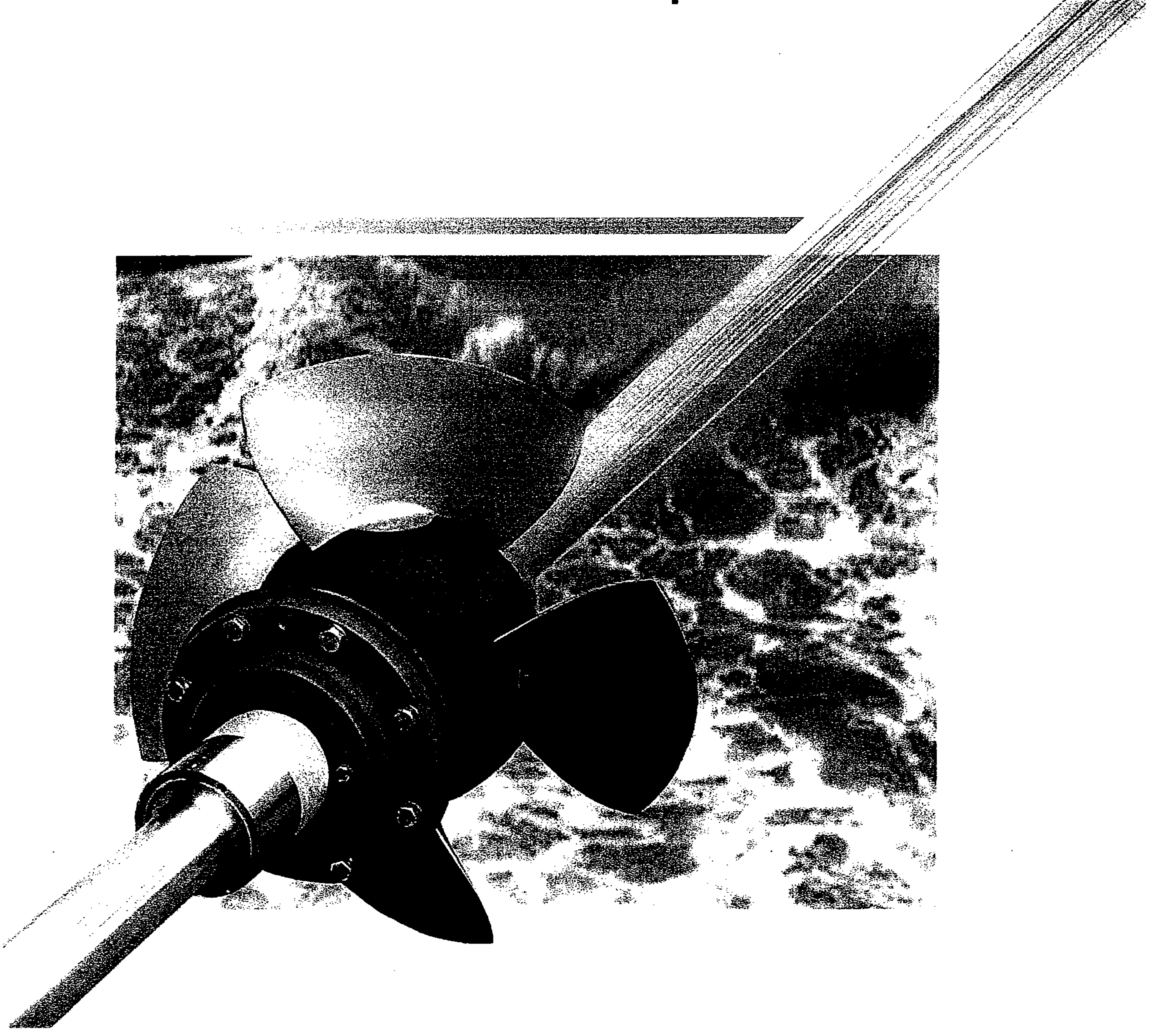
OSSBERGER

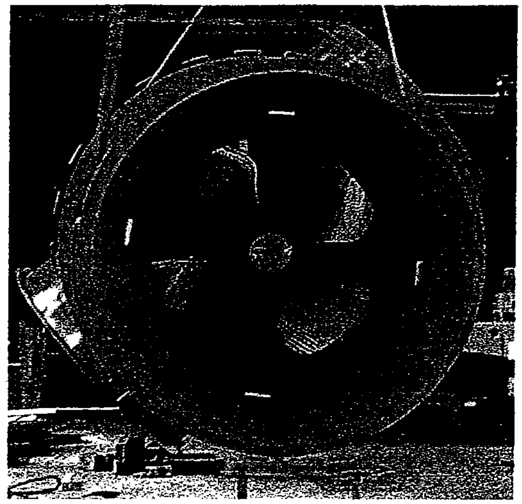
Kaplan-Turbine



OSSBERGER Hydro's aim since more than 100 years is generating electricity from water, creating ecologically friendly energy from a natural and ever-renewable source.

We are offering you the following equipment of first quality: Patented OSSBERGER®-Turbines, Kaplan-Turbines, governors for water turbines and automatic trashrack cleaners. All products are continuously optimised on the company's own test stands, to guarantee the best efficiencies and effectiveness. Finally the reliability of your investment is secured by comprehensive services granted in all parts of the world.

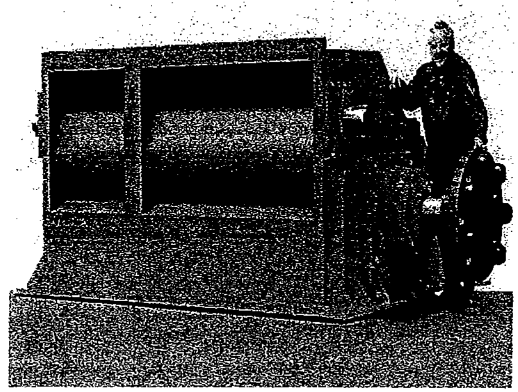
More than 9000 installed OSSBERGER units in more than 100 countries world-wide – take part in our successful history!



OSSBERGER Hydro sieht seit mehr als 100 Jahren Sinn und Zweck aller Bemühungen darin, Strom aus Wasser zu machen, umweltfreundliche Energie aus natürlicher und sich stets erneuernder Quelle zu schöpfen.

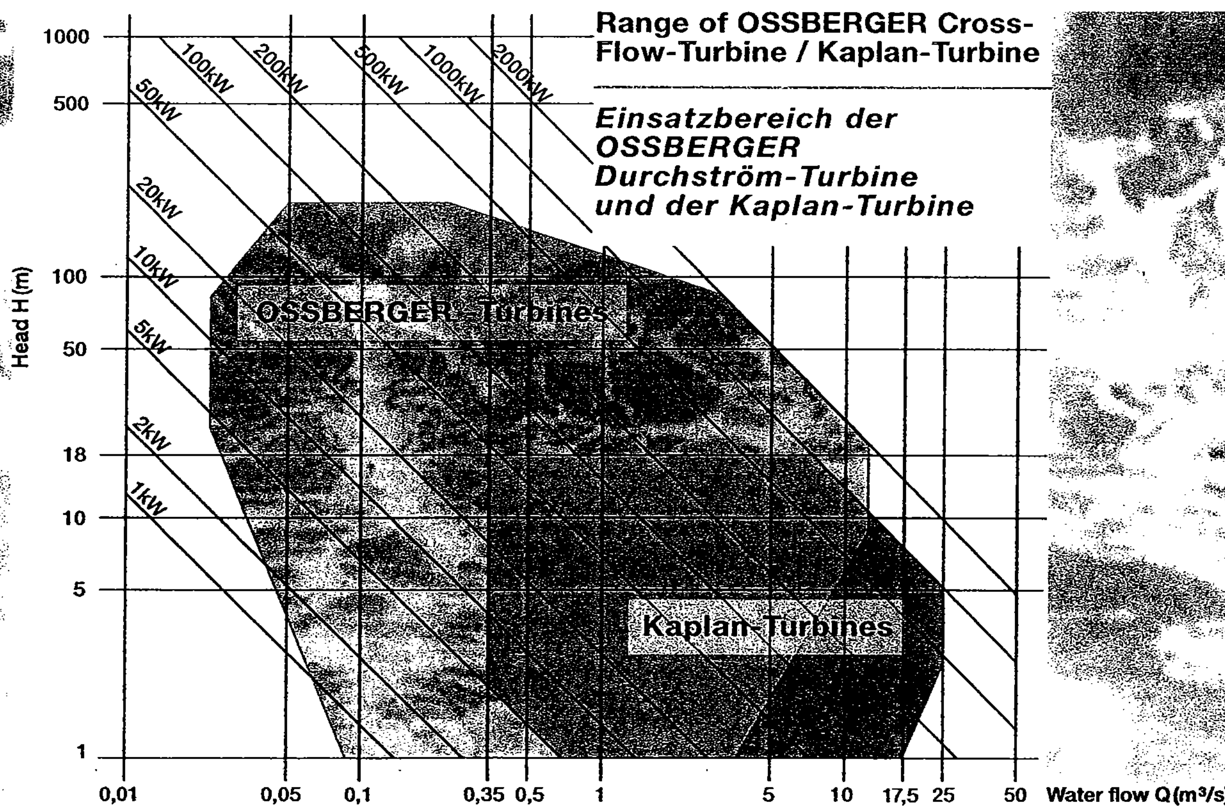
In erstklassiger Qualität bieten wir Ihnen: patentierte OSSBERGER®-Turbinen, Kaplan-Turbinen, Wasserturbinenregler sowie automatische Rechenreinigungsanlagen. Die Produkte werden auf firmeneigenen Versuchsständen fortlaufend optimiert und garantieren Ihnen somit höchste Wirkungsgrade und Effizienz. Umfassende Serviceleistungen weltweit runden die Sicherheit Ihrer Investition ab.

Mehr als 9000 installierte OSSBERGER-Anlagen in über 100 Ländern dieser Welt – werden auch Sie Teil dieser Erfolgsgeschichte!



Range of OSSBERGER Cross-Flow-Turbine / Kaplan-Turbine

Einsatzbereich der OSSBERGER Durchström-Turbine und der Kaplan-Turbine

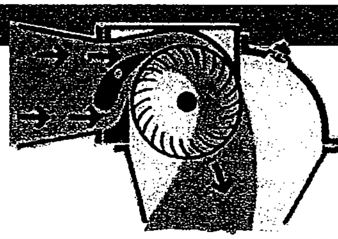
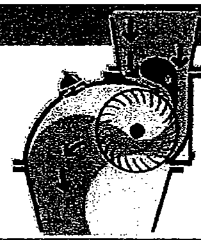
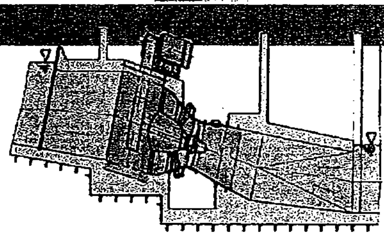
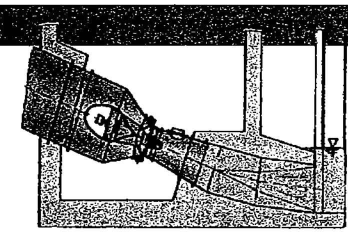
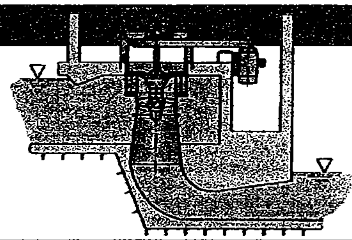
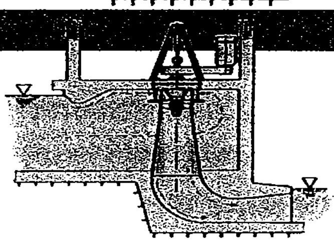


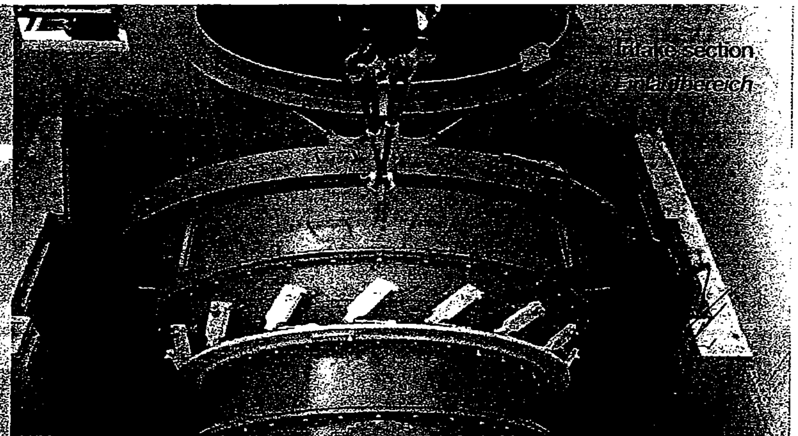
Further information on the OSSBERGER®-Turbine can be derived from the leaflet "The Original OSSBERGER®-Turbine"

Mehr über die OSSBERGER®-Turbine finden Sie im Prospekt „Die Original OSSBERGER®-Turbine"

program

Programm

	Type	Runner diameter Laufraddurchmesser (m)	H (m)	Q (m^3/s)	N (kW)
	OSSBERGER®-Turbine Inflow horizontal *OSSBERGER®-Turbine Zufluss horizontal*	*0,30 - 1,25*	*2 - 200*	*0,1 - 13,0*	*10 - 2000*
	OSSBERGER®-Turbine Inflow vertical *OSSBERGER®-Turbine Zufluss vertikal*	*0,30 - 1,25*	*2 - 200*	*0,1 - 13,0*	*10 - 2000*
	Bulb turbines of the Kaplan type model A *Kaplan-Rohrturbine Bauform A*	*0,63 - 2,24*	*1 - 8*	*1,5 - 30,0*	*50 - 2000*
	Bulb turbines of the Kaplan type model R *Kaplan-Rohrturbine Bauform R*	*0,63 - 0,90*	*3 - 12*	*1,5 - 7,0*	*40 - 700*
	Kaplan-Turbine model T *Kaplan-Turbine Bauform T*	*0,80 - 3,00*	*1 - 12*	*2,0 - 40,0*	*30 - 2000*
	Kaplan-Turbine model K *Kaplan-Turbine Bauform K*	*0,25 - 0,90*	*1 - 12*	*0,2 - 5,3*	*3 - 500*

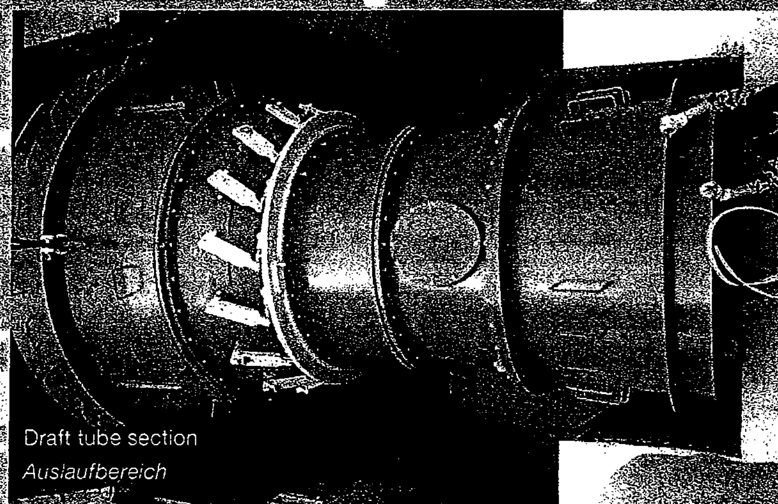


Blade section
Laufbereich

You may expect

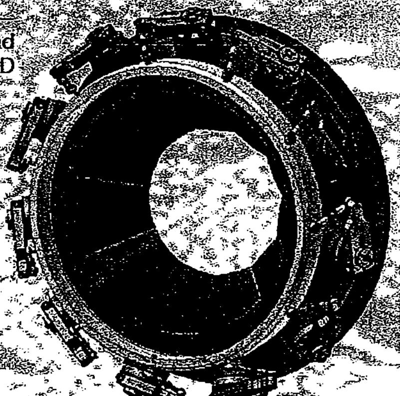
Flat efficiency curve:

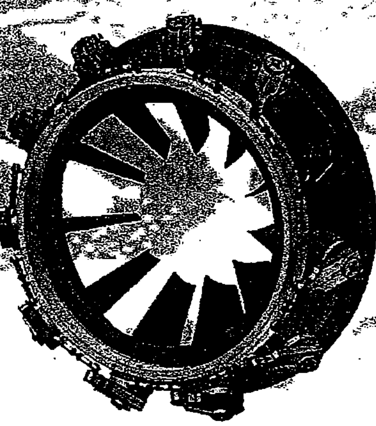
- excess design flow
- larger annual performance
- maintenance-free guide vane bearings
- turn over in spares < 0,5 %
- individual plan of installation
- preliminary assembly at the factory and detailed, user-friendly documentation: Either ease owner participation during installation or alternatively short installation schedules by using the OSSBERGER-team
- compact, easy to erect and maintenance-friendly construction
- actuaction of wicket gates and runner blades in dry area
- easy access to any wearing part
- durable anticorrosive protection
- flexible adaptation of speed
- design and engineering using CAD
- runner with four or five blades
- wicket gates adjustable – runner blades fixed
- double regulated unit



Draft tube section
Auslaufbereich

Wicket gate simulation and analysis at 3 D





Leitapparat – Simulation und Analyse in 3 D

Was Sie erwarten dürfen

Flacher Verlauf des Wirkungsgrades:

- *höherer Ausbaugrad*
- *größere Jahresarbeit*
- *wartungsfreie Leitschaufellager*
- *Ersatzteilumsatz < 0,5 %*
- *individueller Turbinenaufstellungsplan*
- *Vormontage im Werk und eine ausführliche, leicht verständliche Dokumentation: Entweder Montage in Eigenregie oder kurze Montagezeiten durch das OSSBERGER-Montageteam*
- *kompakte, montagefreundliche, wartungsarme Konstruktion*
- *Antrieb des Leitrads komplett außerhalb des Wassers*
- *alle Verschleißteile gut zugänglich*
- *dauerhafter Korrosionsschutz*
- *flexible Drehzahlanpassung*
- *Entwicklung und Konstruktion mit CAD*
- *vier- oder fünf Laufradflügel*
- *Laufrad fest – Leitrad reguliert*
- *doppelt reguliert*

Your benefit

Higher annual performance at the run-of-the-river unit:

Typical Flow Duration curve:
Turbines with flat efficiency curve can be designed for a larger flow rate, without restricting generation at partial loads.

Thus they are generating at 100 days per year at high flows and at 130 days per year at low flows the marked additional performance.

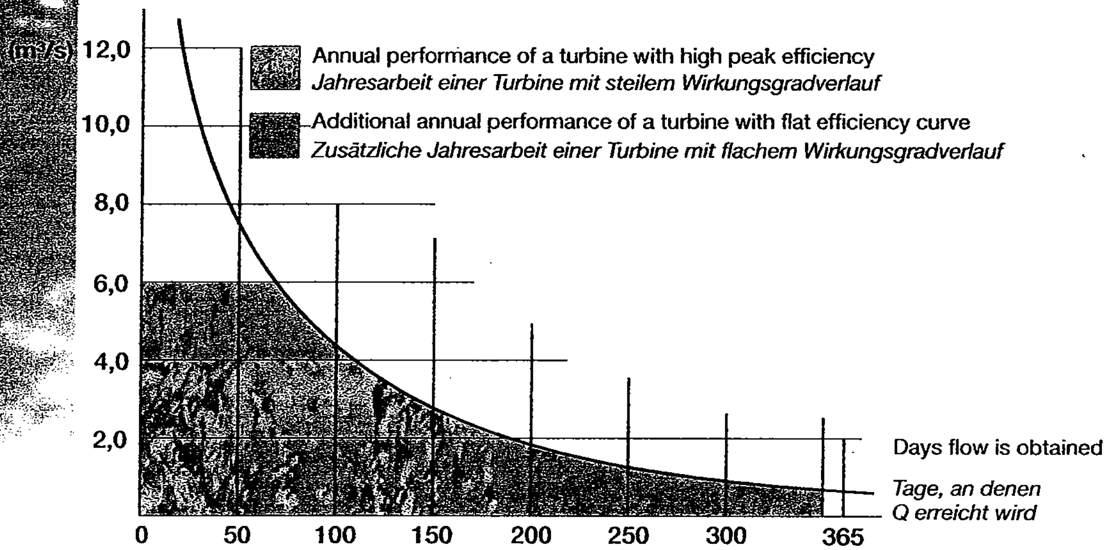
Ihr Nutzen

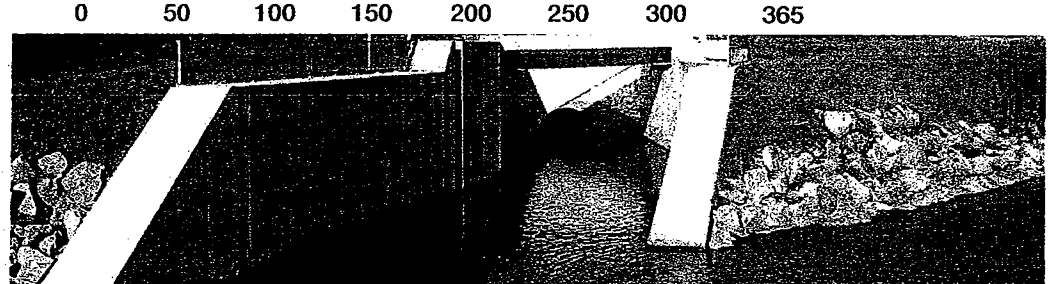
Höhere Jahresarbeit des Laufwasserkraftwerkes:

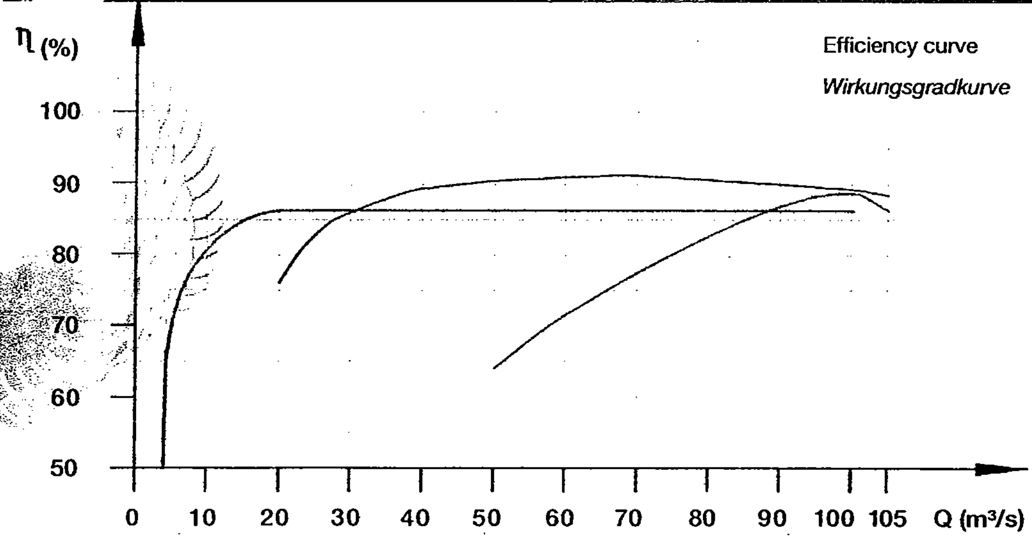
Typische Wassermengendauerlinie:

Turbinen mit flachem Wirkungsgradverlauf können - ohne Nutzungseinbußen im Teillastbereich - für eine größere Nennwassermenge ausgelegt werden.

Dann produzieren Sie an 100 Tagen bei Vollwasser und an weiteren 130 Tagen bei kleiner Abflussmenge die markierte Mehrarbeit.







— OSSBERGER®-Turbine — Kaplan bulb turbine wicket gate regulated — Kaplanbulb turbine double regulated

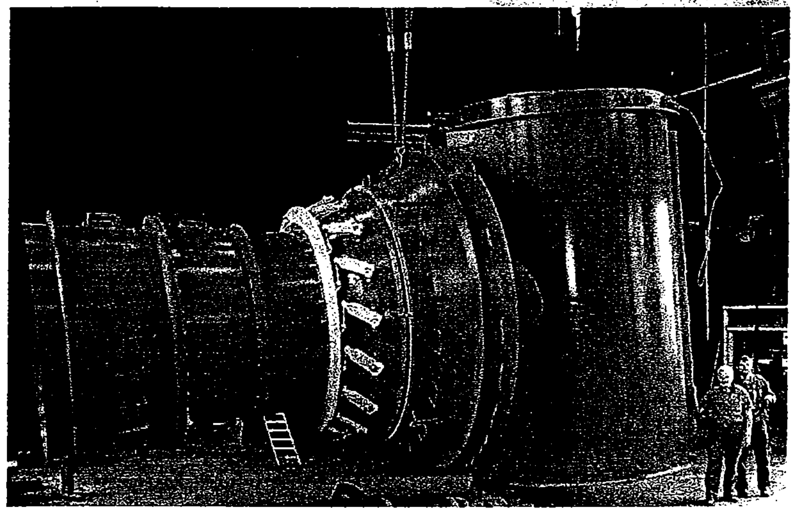
— OSSBERGER®-Turbine — Kaplan-Turbine Leitrad geregelt — Kaplan-Turbine doppelt geregelt

Kaplan Bulb turbines

- large flow
- low civil requirements with new building structures
- optimal in case of frontal inflow and discharge

You will get this turbine as a compact unit and completely mounted.
It only needs to be connected to the draft tube which has been concreted already.

Models A
(Bulb turbine with housing made in concrete)
and R (Bulb turbine for penstock connection)
are available.

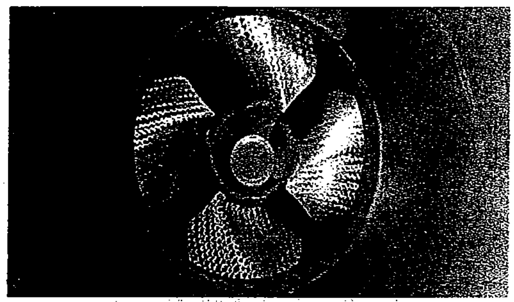


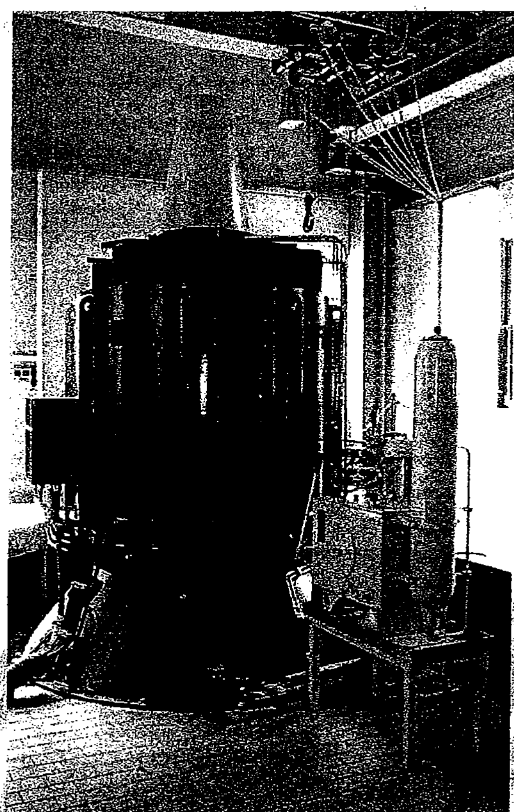
Kaplan-Rohrturbinen

- *großer Durchfluss*
- *geringer Bauaufwand bei Neubauten*
- *optimal bei frontaler Zu- und Abströmung*

Sie erhalten diese Turbine als kompaktes Aggregat komplett montiert angeliefert.
Es muss lediglich an das bereits einbetonierte Saugrohr angeschlossen werden.

Zur Auswahl stehen die Bauformen A (Rohrturbine mit Betongehäuse) und R (Rohrturbine für Rohrleitungsanschluss).





Kaplan-Turbines

If an existing turbine needs to be replaced the Kaplan-Turbine is outstanding for its excellent adaptability. Insignificant changes of the existing building structures are mostly sufficient.

Suitable for the conditions of your power station models K and T are available.

The turbine is delivered as a compact unit and completely mounted up to 1.26 m runner diameter. With runner diameters larger than 1.41 m transportable assembly units are provided.

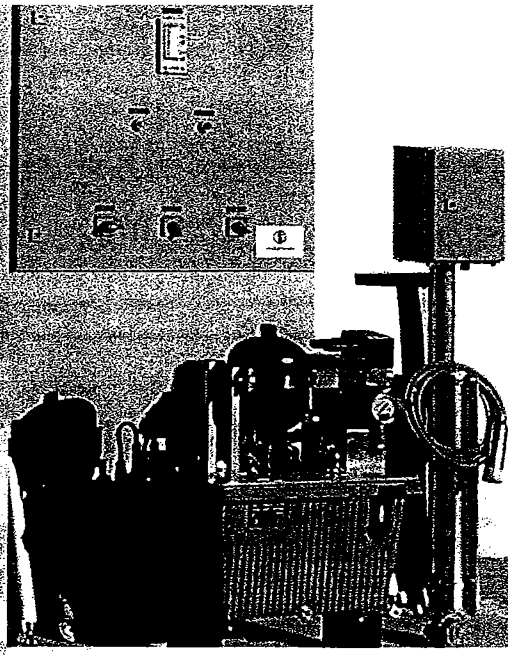
Kaplan-Turbinen

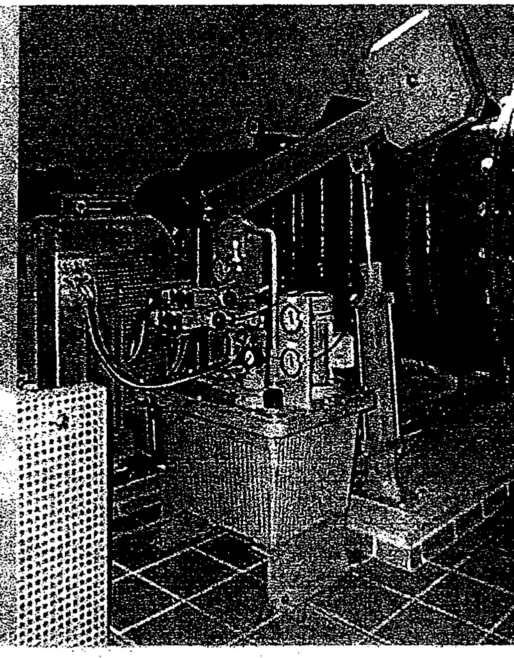
Geht es um den Ersatz einer bestehenden Turbine, zeichnet sich die Kaplan-Turbine durch ihre exzellente Anpassungsfähigkeit aus.
Es reichen meist unbedeutende Änderungen an der vorhandenen Bausubstanz.

Angepasst an die Verhältnisse Ihres Kraftwerkes stehen die Bauformen K und T zur Verfügung.

Bis 1,26 m Laufraddurchmesser erhalten Sie die Turbine als kompaktes Aggregat komplett montiert.

Ab einem Laufraddurchmesser von 1,41 m liefern wir Ihnen transportfähige Baugruppen.





Turbine Regulator

Ossberger Water Turbine Regulator suitable for:

- isolated operation
- grid-parallel operation
- asynchronous operation

Characteristics:

Water level registration beneath the water surface by pressure probe

- functioning without restrictions even in case of ice formation
- pollution like leaves etc. are retained from the probe

Digital transmission of the water level signal

- no signal corruption between intake basin and turbine house
- the penstock length is without significance
- influences by power cable induction etc. are excluded

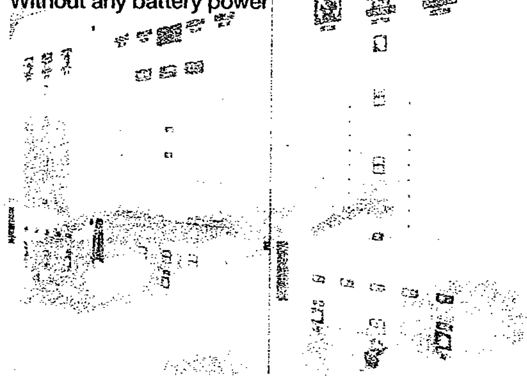
Displays at switchboard

- display of all regulating values at the switch board directly
- no conversion required into nominal values

Multifunctional unit

- direct entering of all parameters into the multi functional unit
- no input units required
- the regulating parameters may even be modified by non-experts in accordance with the operating instructions
- long product life

Without any battery power



Regel- und Steuereinrichtung

Ossberger-Wasserturbinen-Regler für:

- *Inselbetrieb*
- *Netzparallelbetrieb*
- *Asynchronbetrieb*

Charakteristik:

Wasserstandserfassung unterhalb der Wasseroberfläche mittels Drucksonde

- *Funktion auch bei Eisbildung ohne Einschränkung gewährleistet*
- *Verschmutzungen werden von der Sonde ferngehalten*

Digitale Übertragung des Wasserstandsignals

- *keine Verfälschung des Signals*
- *Rohrleitungslänge hat keinen Einfluss*
- *keine Störung durch Induktion*

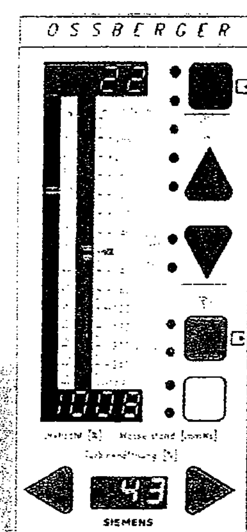
Anzeigen am Schaltschrank

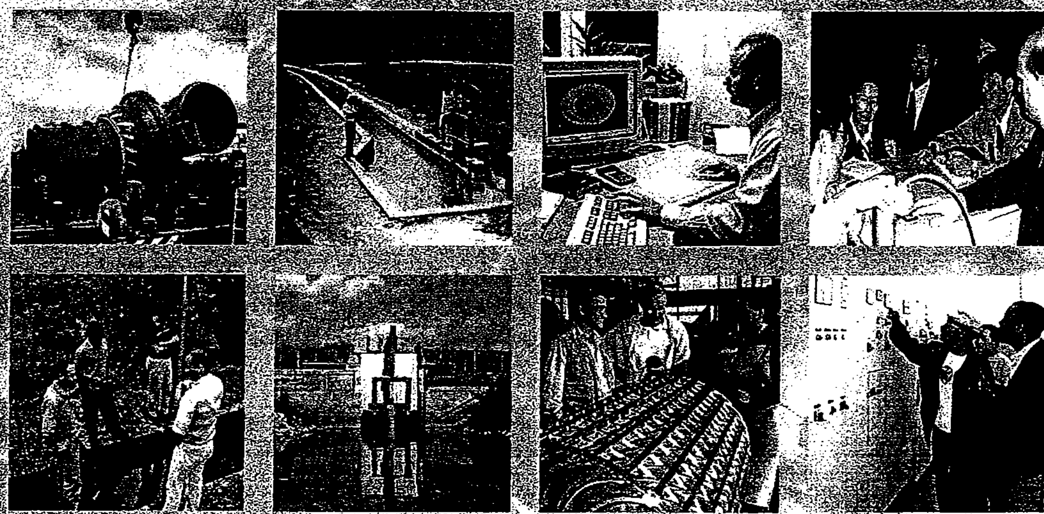
- *Anzeige sämtlicher Regelgrößen*
- *Umrechnung in Nenngrößen entfällt*

Multifunktionseinheit

- *direkte Eingabe aller Parameter*
- *keine Eingabegeräte*
- *einfache Änderung der Parameter*
- *lange technische Lebensdauer*

Keine externe Stromversorgung (Batterie)





Small scaled hydropower stations need to comply with the natural preconditions and various operating tasks.

Thus OSSBERGER manufactures tailor-made water power plants.

Kleine Wasserkraftwerke müssen den von der Natur gegebenen Verhältnissen und den verschiedenen Betriebsaufgaben gerecht werden.

Deshalb baut OSSBERGER massgeschneiderte Wasserkraftwerke.

Experience and partnership provide future-oriented solutions, securing the profitability of your investment for long years.

Erfahrung und Partnerschaft schaffen zukunftsweisende Lösungen und sichern langfristig die Rentabilität Ihrer Investition.

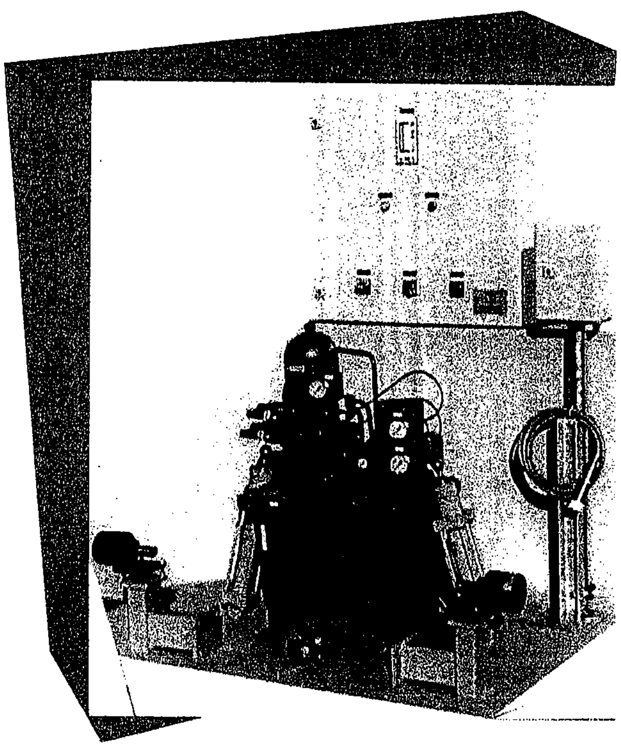
OSSBERGER

OSSBERGER GmbH + Co
Otto-Rieder-Straße 7, D- 91781 Weißenburg
P.O.Box 4 25, D - 91773 Weißenburg
Fon 00 49 (0) 91 41 / 9 77 - 0
Fax 00 49 (0) 91 41 / 9 77 - 20
E-Mail ossberger@ossberger.de
web www.ossberger.de

Turbine Governors for Hydropower Applications

OSSBERGER

Type	A-2-H	A-2-ER	A-2-DR	S-2-DR	S-2-MK/R/So	S-2-MK	KL
Generator	Induction Generator			Synchronous Generator			
Operation	grid connected operation				stand-alone or grid connected	stand-alone operation	
Task	maximised annual production					demand control	



Hydrostatic pressure receiver probe for **water level registration**

Support bracket with protective tube for sensor probe, made of hot-dipped galvanised steel, for installation to the intake wall

Terminal box – protection class IP 66, powder-coated, with integrated over voltage protection and sensor cable tension relief device

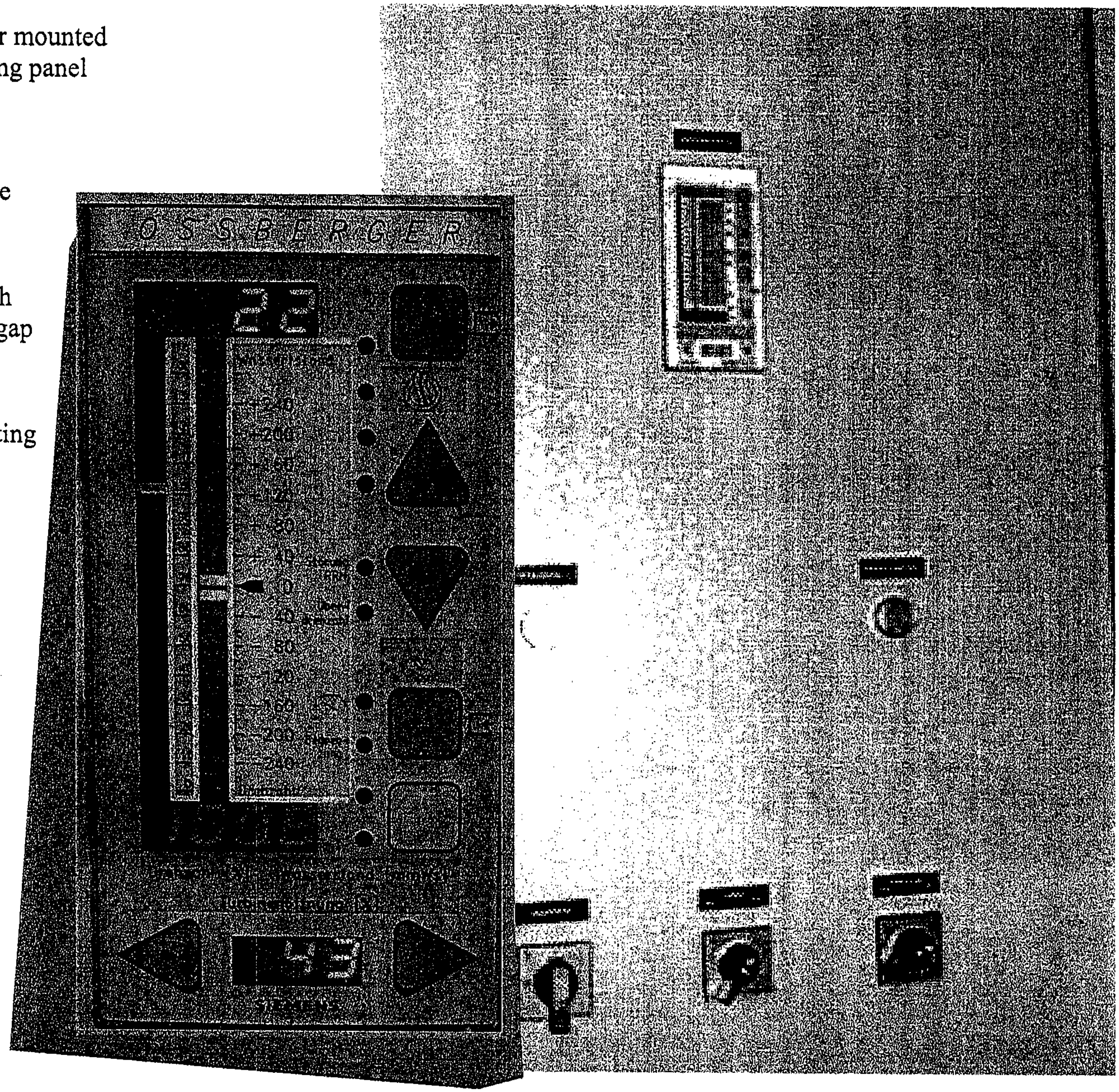
Over voltage protection with suppressor diode and gas ignition gap for nominal leakage current rating of 10 kA

Brushless hollow-shaft tach-generator for **speed registration**, factory-mounted to turbine shaft, with special bearing design for maintenance-free operation

Brochure S-86

Control panel, Class IP 42, with door mounted operational devices and inside mounting panel

- Main switch
- Control transformer
- **Multifunction unit**, programmable for various regulating and control functions
- Sensor over voltage protection with suppressor diode and gas ignition gap for peak current rating of 10 kA
- Over voltage protection of control voltage system for peak current rating of 2.5 kA
- Operating mode selector switch



Optimisation by cell sequencing

- High efficient, short-circuit proof frequency clocked power unit for DC supply
- Motor protective starter for hydraulic pump
- Twin annunciators
  - ready for operation
  - generator on line
- Test terminals for easy testing and quick commissioning

Speed registration

- Brushless hollow-shaft tach-generator, factory-mounted to turbine shaft
- special bearing design for maintenance-free operation

Opening feedback signal - Registration of guide vane positions:

- rotating angle transmitters with integrated electronic, factory-mounted to turbine.
- no wear due to contact free capacitive angular movement sensing
- zero tolerance bellows couplings for high precision transfer of guide vane positions

Hydraulic power unit

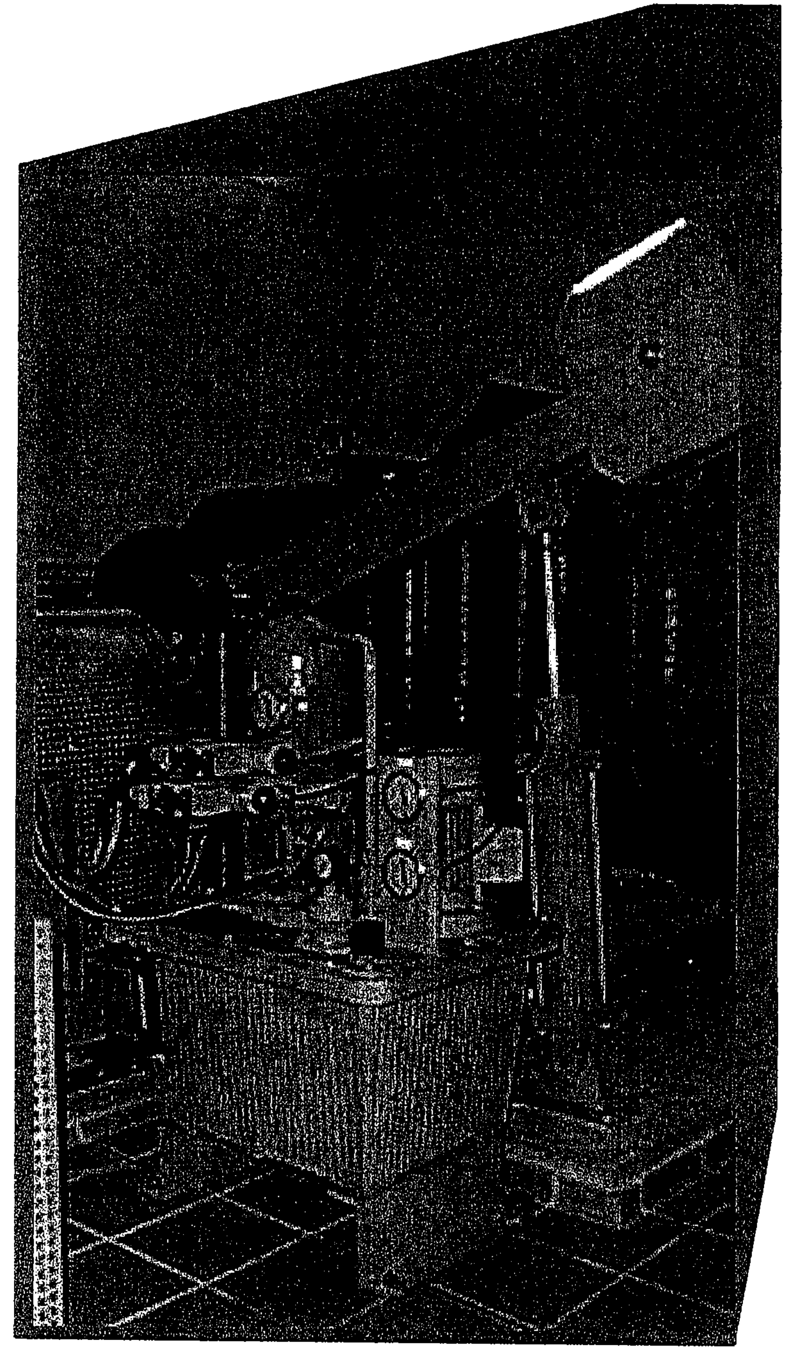
- Aluminum die-cast casing of 40 litres capacity
- Motor-driven gear pump, motor 550 W, pump 2.7 lit/min
- Pressure accumulator with a "pressure-liter" number < 200 ⇒ no pressure testing required on site to comply with official technical regulations
- two adjustable pressure relief valves
- two pressure gauges 0 ... 40 bar for operating pressure
- 0 ... 100 bar for system pressure
- two direct controlled proportional valves with electric position feedback and integrated controls
- two seat valves for emergency shut-down without utilising the control valves
- return filter with by-pass and visual oil contamination display

Lever arms:

- Made of solid steel, destined for reliable stress-free opening of the turbine guide vanes and adapted to fit the assigned turbine guide vane opening angle
- dead weights to assure a reliable turbine closing without requiring auxiliary energy

Hydraulic cylinders:

- Low working pressure
- cylinder base plate with hinged bearing



OSSBERGER TURBINES, INC PO Box 736 Hayes, VA, USA 23072 TEL: 804-360-7992 FAX: 866-552-9946 e-mail: htsinc@erols.com

VA Tech Hydro

Dougherty, Dana

From: mcqmark@comcast.net
Sent: Tuesday, May 13, 2008 11:54 AM
To: Dougherty, Dana
Cc: Thomas Taylor; Keith Pomeroy
Subject: City of Ann Arbor, MI, USA, Argo & Geddes
Attachments: Argo 01.pdf

Dear Sir,

In response to your inquiry, please find attached our budget quote on turbine generator equipment for your Ann Arbor Hydro Projects. Should you have any questions or require additional information, please contact me.

Regards
Mark Barandy

VA TECH HYDRO Canada Inc.
115 Central Avenue
West Caldwell, NJ 07006
Phone: 973 403 8210
FAX: 973 403 7914
mark.barandy@andritz.com
www.vatech-hydro.com

From: Dougherty, Dana
Sent: Wednesday, April 30, 2008 1:09 PM
To: 'contact@vatech-hydro.com'
Subject: City of Ann Arbor, MI, USA

We are currently performing a feasibility study of redeveloping hydroelectricity at the Argo and Geddes on the Huron River in the City of Ann Arbor, MI,USA. These facilities are owned and operated by the City of Ann Arbor who has commissioned us to perform the study. This is actually an update of a study that we did some 27 years ago (1981). As a result of that study the City reactivated two sites (Barton and Superior) which are currently operating.

We would appreciate your recommendation on equipment selection for these sites, a rough preliminary estimate of equipment cost (water to wire) and estimated power production (you can use the spreadsheet provided if you choose).

To assist in your evaluation we have attached head/flow duration data for each site. Please note that we have included two options for the Argo site, the first being to place the powerhouse left and adjacent to the spillway and the second being to place the powerhouse at the end of the existing millrace (this will result in two foot increased head however is problematic due to stability concerns with the right millrace embankment and associated environmental concerns). We have also attached a plan view drawing of each site as well as photos.

Photo Log:

- 004 - Old Argo Powerhouse. This has been decommissioned and is no longer owned by the City.
- 018 - Argo Spillway. We are looking at placing the new powerhouse in the left embankment.
- 016 - Old millrace. Option Two would include placing the powerhouse at the end of the millrace.
- 025 - Geddes left spillway.
- 026 - Geddes left embankment. Proposed powerhouse location.
- 027 - Geddes left embankment view from downstream.
- 034 - Geddes Dam view from upstream.

We would like to evaluate development to three capacities; 25%, 50%, & 75% flow exceedance. The Barton and Superior sites that were previously recommissioned utilized Voest Alpine equipment.. Barton has a single vertical propeller unit (900kw) installed in an existing powerhouse and Superior has a single "S" Kaplan propeller unit (570kw) installed in a new powerhouse with siphon intake. The Superior site is very similar to Geddes with regard to head/flow.

We look forward to receiving your response to this inquiry. Please do not hesitate to contact us with any questions. As the City has us under a very tight timeline to complete our study we would appreciate an expedient response to this request.

Thanks,

<<agro_dam_embankments_11x17.tif>> <<geddes_dam_earthwork_11x17.tif>> <<Est. of Energy Production - Contractor.xls>>

Dana M Dougherty, P.E.
Stantec
3959 Research Park Drive
Ann Arbor MI 48108-2216
Ph: (734) 214-2521
Fx: (734) 761-1200
dana.dougherty@stantec.com
stantec.com

VA TECH HYDRO ANDRITZ

May 13, 2008

Stantec
3959 Research Park Drive
Ann Arbor MI 48108-2216

Attention: Mr. Dana M Dougherty, P.E.

Subject: Ann Arbor Small Hydro Projects
Your e-mails of April 30 and May 12, 2008

Dear Sir:

Thank you for your recent inquiry requesting budgetary price and technical information on hydroturbine equipment for the subject application. Based on the net head and discharge information you submitted in your e-mail of April 30, 2008, we propose for each site condition, one horizontal Kaplan turbine including a synchronous generator and hydraulic pressure unit (HPU) for operation of the turbine wicket gates and blades.

The turbine arrangement proposed for these sites is a horizontal S-type unit driving the generator (through a speed increaser) which is located downstream of the draft tube elbow. The turbine is proposed to have adjustable runner blades and wicket gates resulting in a wide operating flow range. Differing arrangements can be provided should such better suit your powerhouse designs and site civil constraints. These include an inclined or vertical tubular type unit with the shaft and generator upstream of the turbine. In either case, preliminary pricing would be similar to that of the S-Type unit proposed.

Also proposed is a controls/switchgear package which will have full manual and automatic operation capability and include limited DC backup equipment and station service equipment. Note that the unit proposed is not designed to operate off the utility grid (speed governing, isolated operation). Main power transformer and high voltage switchyard equipment are not included.

Attached is a technical data/price sheet covering our suggested equipment solution for each requested condition. Also included for your reference are turbine performance curves and a typical general arrangement drawing of a similar size unit.

VA TECH HYDRO Canada Inc.
115 Central Avenue
West Caldwell, NJ 07006 USA

Tel: (973) 403-8210
Fax: (973) 403-7914
E-mail: mark.barandy@andritz.com

Price quoted is F.O.B. jobsite (assuming easy access to site via commercial carrier) and includes any applicable import duties. Delivery time for the proposed equipment is approximately 20 months after contract award.

The turbine equipment is proposed to be designed by VA TECH Bouvier Hydro in Fontaine, France. VA TECH HYDRO will make use of its global network of production facilities to source the manufacturing of the turbine equipment.

Should you have any questions or wish to discuss this or other possible unit arrangements, please contact me at:

VA TECH HYDRO Canada Inc.
115 Central Avenue
West Caldwell, NJ 07006

Tel. No.: 973 403 8210
FAX No.: 973 403 7914
e-mail: mark.barandy@andritz.com

Very truly yours,

VA TECH HYDRO Canada Inc.

Mark Barandy

enc.

cc K. Pomeroy; VA TECH HYDRO Canada, Inc.
T. Taylor; VA TECH HYDRO Canada, Inc.

Project: Argo Small Hydro Project – Option 1

Turbine Quantity/Type	-	1 - Horizontal S-Type Kaplan
Runner Diameter	-	1950 mm, 4 Blade
Turbine Speed	-	150 rpm
Intake Type	-	Axial; Approx 3.3m Diameter
Draft Tube Type	-	Elbow/S-Type
Draft Tube Exit Dimensions	-	4 m Wide x 2.8 m High
Runner Centerline to DT Exit	-	12.7m
Highest Centerline Setting	-	2.0m (above T.W. elevation)
Max Turbine Output	-	422 KW (at 3.05m Net Hd & 15.6 m^3/s)
Speed Increaser Type	-	Parallel Shaft Horizontal Offset
Generator Type	-	Horizontal Synchronous
Generator Rating (Nominal)	-	400 KW (Nominal)
Speed	-	900 rpm (60 Hz)
Voltage	-	2300 V
Power Factor	-	0.90
Excitation	-	Brushless
Temperature Rise	-	80°C over 40°C Ambient

Budget Price for Turbine, Generator,
Speed Increaser HPU and Controls/switchgear
(equipment supply only) - Approximately US$ 3,490,000

VATECH HYDRO ANDRITZ

Project: Argo Small Hydro Project – Option 2

Turbine Quantity/Type	-	1 - Horizontal S-Type Kaplan
Runner Diameter	-	1770 mm, 4 Blade
Turbine Speed	-	180 rpm
Intake Type	-	Axial; Approx 3m Diameter
Draft Tube Type	-	Elbow/S-Type
Draft Tube Exit Dimensions	-	3.6 m Wide x 2.5 m High
Runner Centerline to DT Exit	-	11.5m
Highest Centerline Setting	-	2.0m (above T.W. elevation)
Max Turbine Output	-	498 KW (at 3.66m Net Hd & 15.6 m^3/s)
Speed Increaser Type	-	Parallel Shaft Horizontal Offset
Generator Type	-	Horizontal Synchronous
Generator Rating (Nominal)	-	470 KW (Nominal)
Speed	-	900 rpm (60 Hz)
Voltage	-	2300 V
Power Factor	-	0.90
Excitation	-	Brushless
Temperature Rise	-	80°C over 40°C Ambient

Budget Price for Turbine, Generator,
Speed Increaser HPU and Controls/switchgear
(equipment supply only) - Approximately US$ 3,290.000

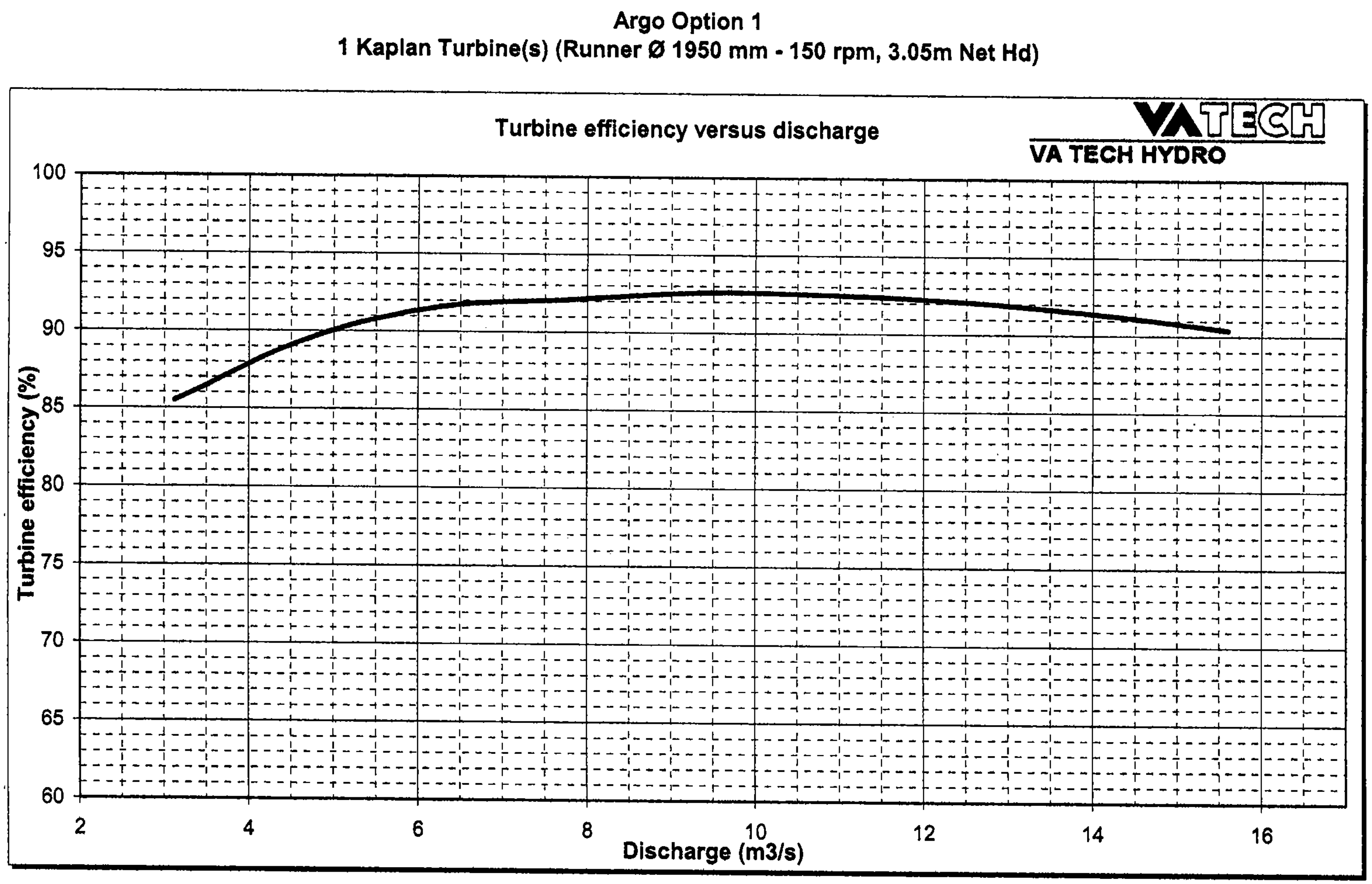
Project: Geddes Small Hydro Project

Turbine Quantity/Type	-	1 - Horizontal S-Type Kaplan
Runner Diameter	-	1770 mm, 4 Blade
Turbine Speed	-	200 rpm
Intake Type	-	Axial; Approx 3m Diameter
Draft Tube Type	-	Elbow/S-Type
Draft Tube Exit Dimensions	-	3.6 m Wide x 2.5 m High
Runner Centerline to DT Exit	-	11.5m
Highest Centerline Setting	-	2.0m (above T.W. elevation)
Max Turbine Output	-	669 KW (at 4.51m Net Hd & 17 m^3/s)
Speed Increaser Type	-	Parallel Shaft Horizontal Offset
Generator Type	-	Horizontal Synchronous
Generator Rating (Nominal)	-	650 KW (Nominal)
Speed	-	900 rpm (60 Hz)
Voltage	-	2300 V
Power Factor	-	0.90
Excitation	-	Brushless
Temperature Rise	-	80^{O}C over 40^{O}C Ambient

Budget Price for Turbine, Generator,
Speed Increaser HPU and Controls/switchgear
(equipment supply only) - Approximately US$ 3,370,000

VA TECH HYDRO — ANDRITZ

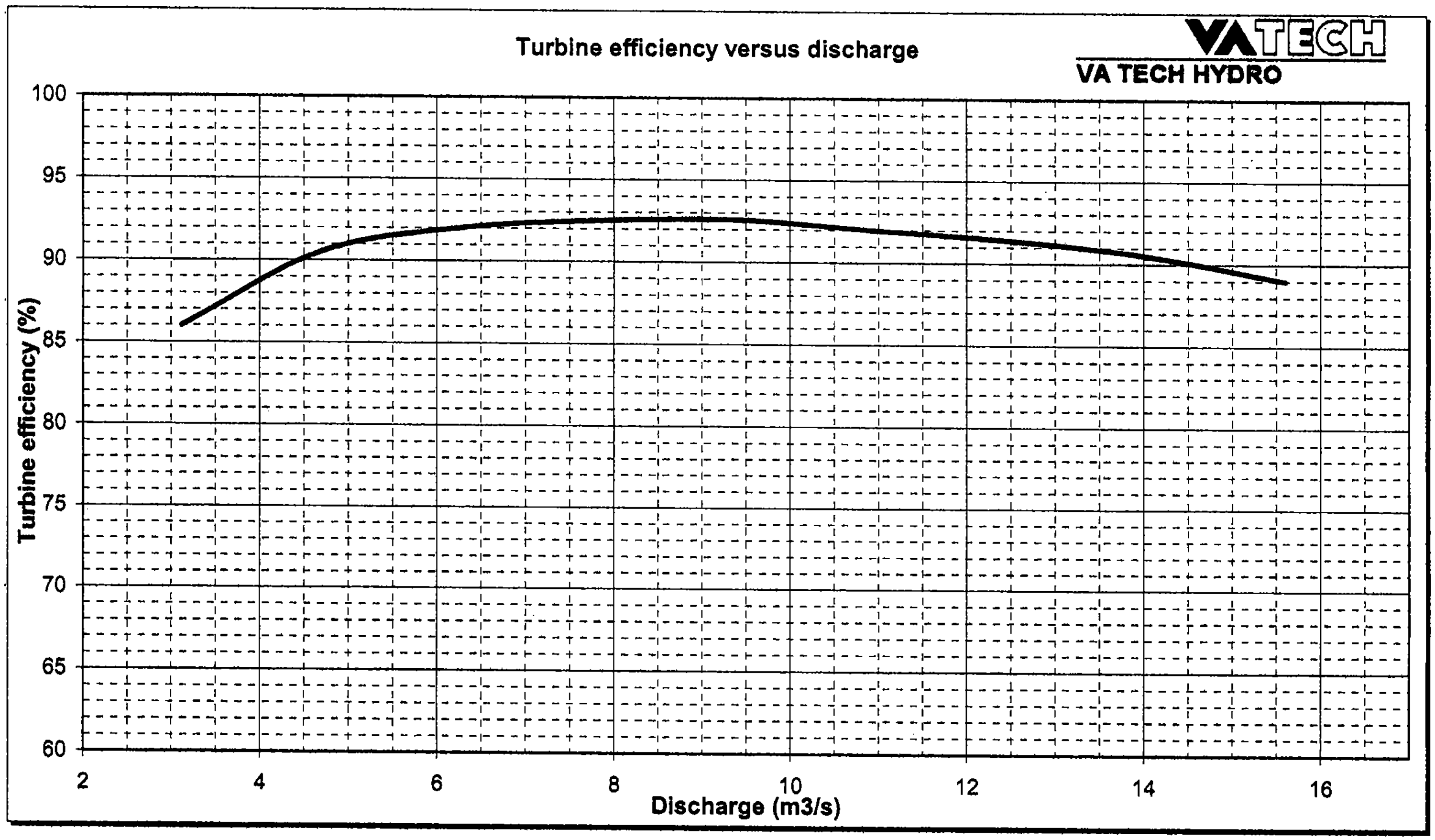
Preliminary Turbine Performance Curve – Argo Option 1



VA TECH HYDRO ANDRITZ

Preliminary Turbine Performance Curve – Argo Option 2

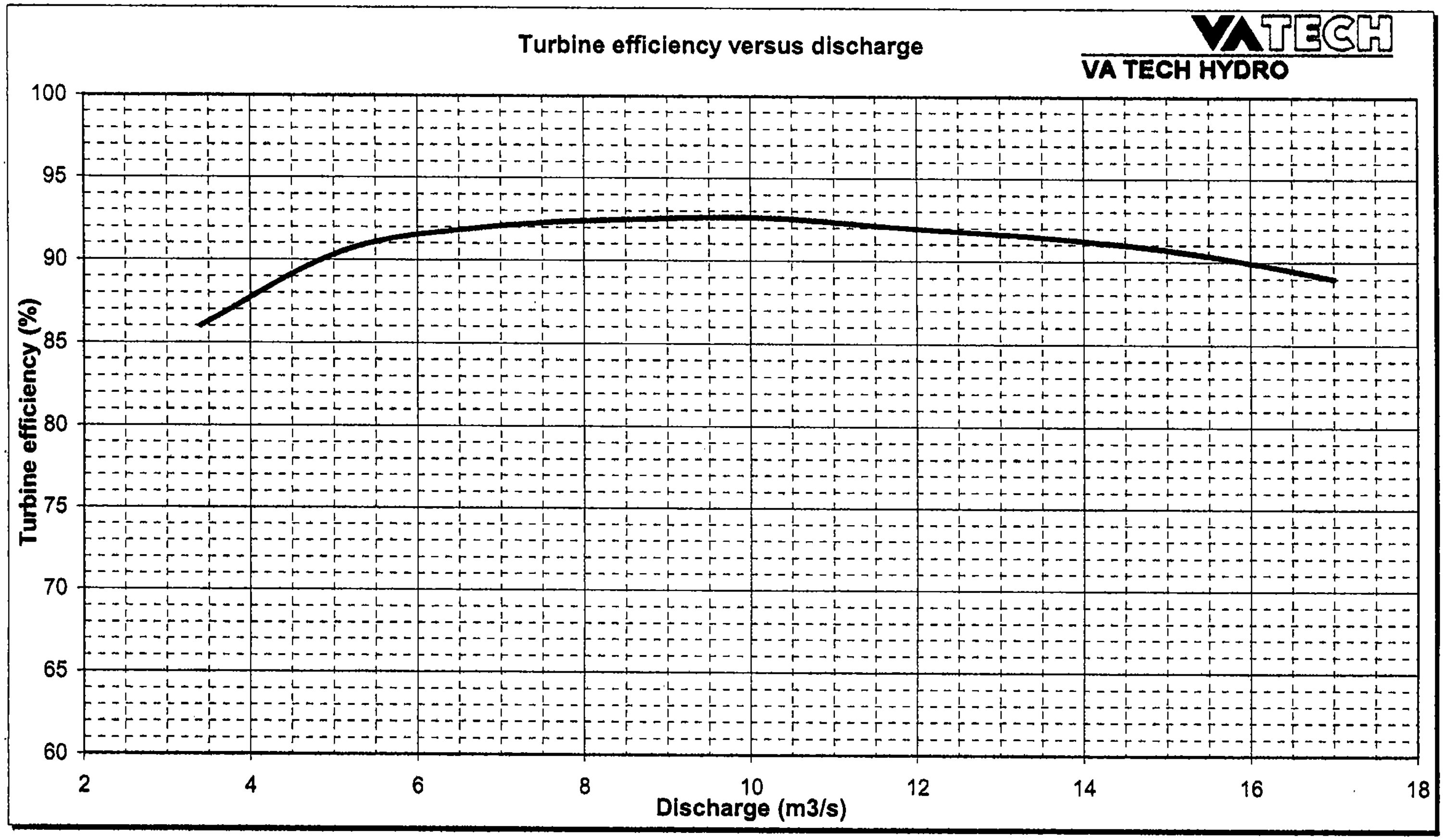
Argo Option 2
1 Kaplan Turbine(s) (Runner Ø 1770 mm - 180 rpm, 3.66m Net Hd)



VA TECH HYDRO ANDRITZ

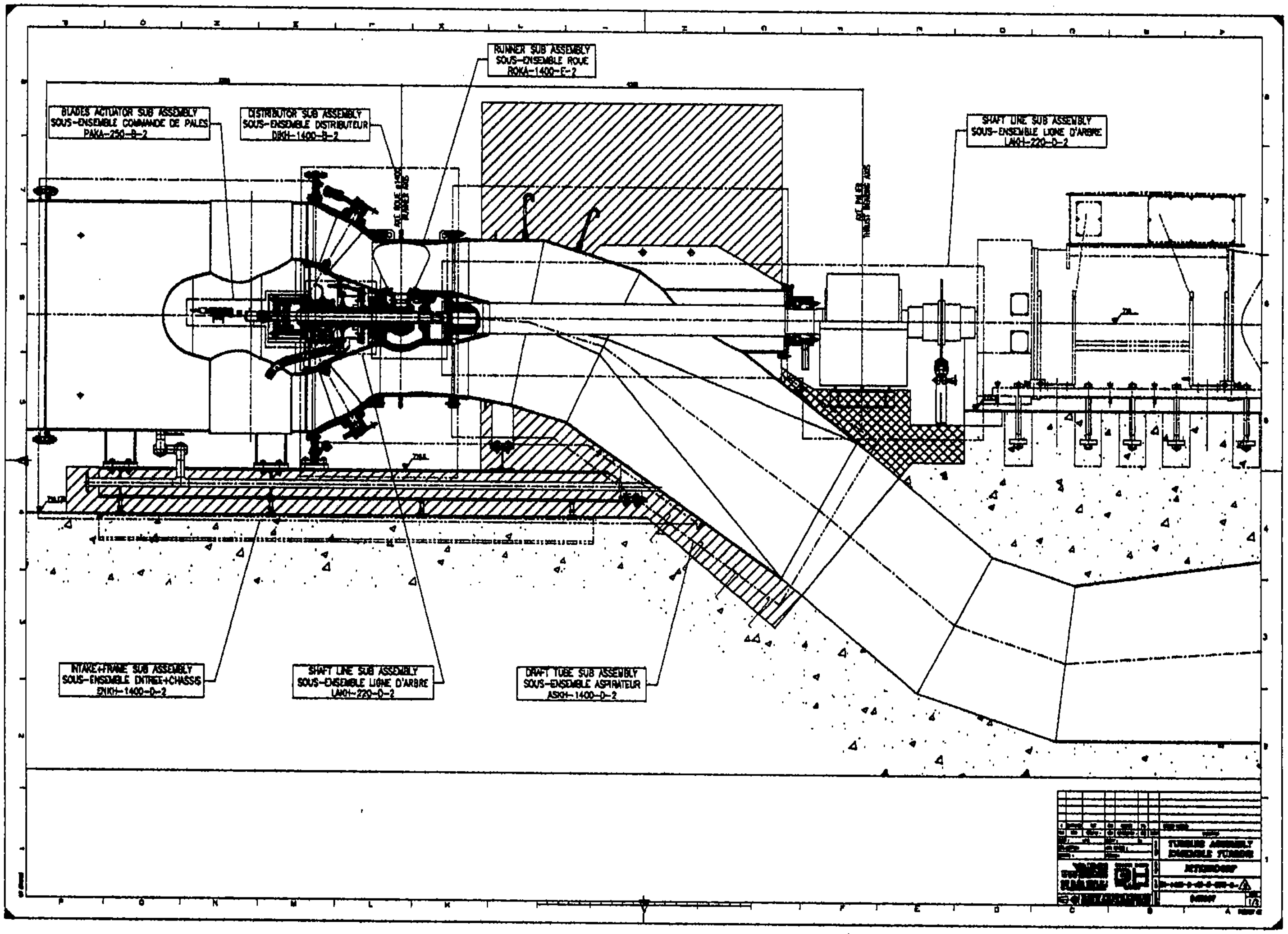
Preliminary Turbine Performance Curve – Geddes

Geddes
1 Kaplan Turbine(s) (Runner Ø 1770 mm - 200 rpm, 4.51m Net Hd)



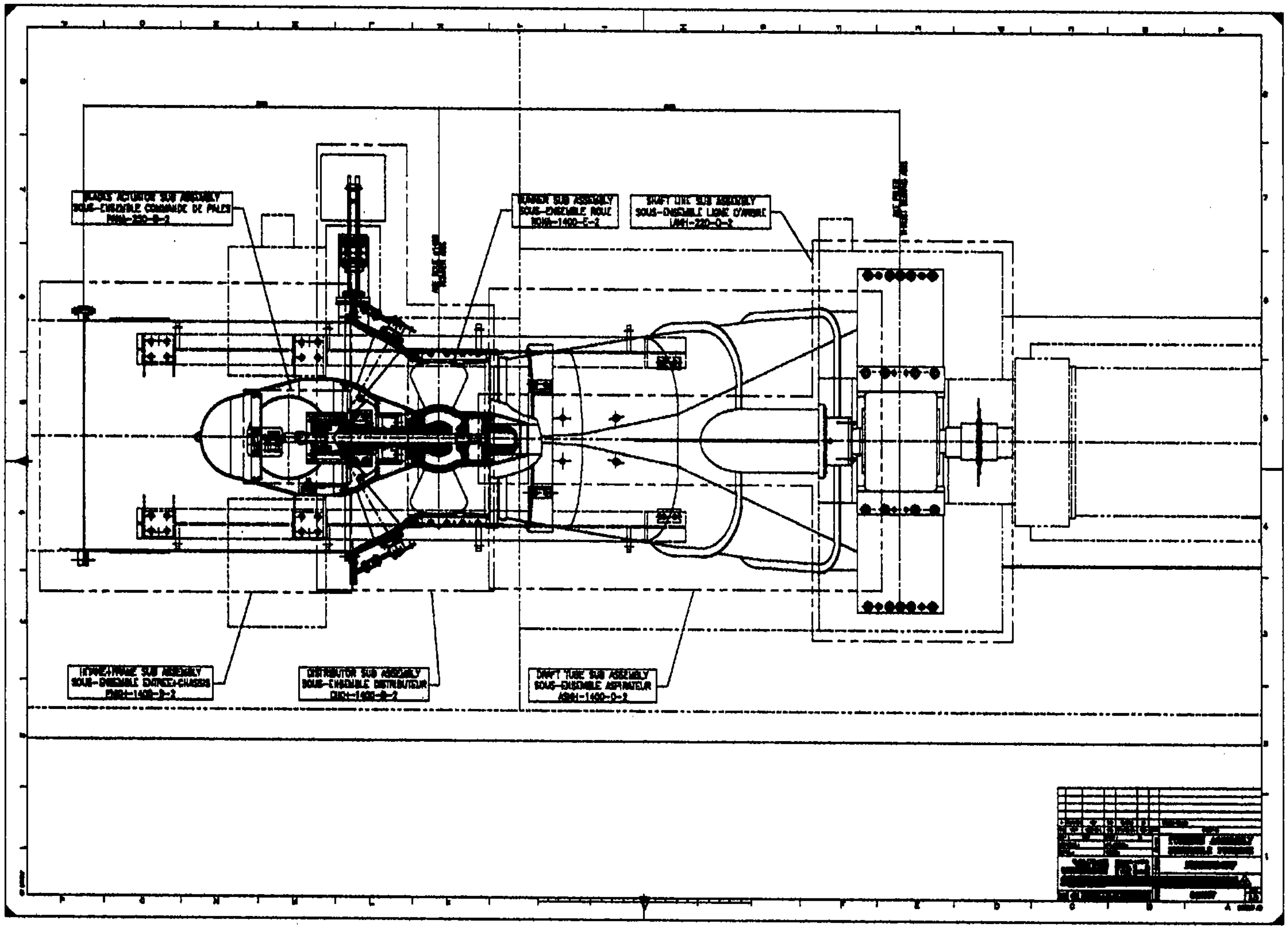
VATECH HYDRO ANDRITZ

Typical General Arrangement (for a similar 1400mm S-Type unit)



VATECH HYDRO ANDRITZ

Typical General Arrangement (for a similar 1400mm S-Type unit)



Voith Siemens

Dougherty, Dana

From: Snyder, Gregory [Gregory.Snyder@vs-hydro.com]
Sent: Friday, April 25, 2008 10:32 AM
To: Dougherty, Dana
Cc: Miller, Ron; Smith, Jeremy
Subject: RE: City of Ann Arbor, MI, USA; Hydro Feasibility Study
Attachments: t2787e S Turbines in Standard Sizes.pdf

Hello Dana,

Glad to hear that the information was useful.

Here is our brochure on standard s-turbines.

Re efficiency, for a quick estimate, use the chart given in the brochure, which is normalized to the peak. For feasibility purposes, use a turbine peak efficiency of 93% and assume this curve is Ok for any head in the rather narrow range you're consideering. (Assume a generator efficiency on the order of 97%, with a relatively flat curve as a function of output.) That should get you close enough to see whether there is potential here.

Good luck with the projects. Please keep us posted.

Greg

From: Dougherty, Dana [mailto:Dana.Dougherty@stantec.com]
Sent: Friday, April 25, 2008 8:47 AM
To: Snyder, Gregory
Cc: Miller, Ron; Smith, Jeremy
Subject: RE: City of Ann Arbor, MI, USA; Hydro Feasibility Study

Greg,

Thanks much for the reply. The information provided is exactly what we need for this "first cut" analysis. Could you possibly forward catalog cut sheets and on these units? How about efficiency data.....any rough numbers available?

Thanks, again.

Dana M Dougherty, P.E.
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Fx: (734) 761-1200
dana.dougherty@stantec.com
stantec.com

From: Snyder, Gregory [mailto:Gregory.Snyder@vs-hydro.com]
Sent: Thursday, April 24, 2008 2:22 PM
To: Dougherty, Dana
Cc: Miller, Ron; Smith, Jeremy
Subject: FW: City of Ann Arbor, MI, USA; Hydro Feasibility Study

Thank you for your inquiry.

By way of introduction, I will say that I am the US Eastern Regional Manager for VSY, working out of York, PA. (My contact information is attached.) Ron Miller therefore forwarded this to me and asked me to support you on this.

There are obviously a large number of configurations which could studied here. We therefore first have to note that the net heads available are limited- it is often difficult to justify a development like this with net heads below 20ft., although it is certainly done, especially with today's energy prices, RPS's & CO2 concerns.

Therefore, we would propose to give you two basic options, have you perform a first-cut feasibility study, and discuss this further if there appears to be merit.

Based on a quick sizing of the two sites, they appear to require very similar turbines & generators. Therefore, our advice would be to procure duplicate units for the two sites, to keep 'one-time' costs to a minimum. This would assume both sites are suited for the same configuration, which in this case we would recommend to be horizontal S-turbines, which are easily-maintained, rugged, and well-suited for a low-head application like this.

We would also comment that with heads this low, at Argo you will probable want to consider developing the higher head option, as we expect the extra 2' to be very important to project feasibility.

All that said, we would suggest considering a single 1.3m diameter, 300kW unit for each plant for the 75% exceedance option. This could likely be a single regulated unit, as they will run essentially wide open through the majority of the year if you are operating on a run-of-the -river mode with no ponding. On a present day, FOB factory basis with normal commercial terms and conditions, you can assume for budgeting purposes that the present-day price for the two units would be $5M, which includes supply of the turbine, generator, governor, and exciter.

For the 25% exceedance option, we would suggest a single full Kaplan turbine at each site with a diameter of approx 2.1m and an output of 700 kw. On the same basis as above, assume a present-day preliminary price of $5.75M.

Best of luck with your studies. Please keep us posted on your progress, and please provide to us the licensing status and an approximate timetable for implementation.

Regards,

Greg Snyder

Eastern Regional Manager
Voith Siemens Hydro Power Generation

From: Dougherty, Dana [mailto:Dana.Dougherty@stantec.com]
Sent: Friday, April 18, 2008 7:07 AM
To: Miller, Ron
Subject: City of Ann Arbor, MI, USA; Hydro Feasibility Study

We are currently performing a feasibility study of redeveloping hydroelectricity at the Argo and Geddes on the Huron River in the City of Ann Arbor, MI,USA. These facilities are owned and operated by the City of Ann Arbor who has commissioned us to perform the study. This is actually an update of a study that we did some 27 years ago (1981). As a result of that study the City reactivated two sites (Barton and Superior) which are currently operating.

We would appreciate your recommendation on equipment selection for these sites, a rough preliminary estimate of equipment cost (water to wire) and estimated power production (you can use the spreadsheet provided if you choose).

To assist in your evaluation we have attached head/flow duration data for each site. Please note that we have included two options for the Argo site, the first being to place the powerhouse left and adjacent to the spillway and the second being to place the powerhouse at the end of the existing millrace (this will result in two foot increased head however is problematic due to stability concerns with the right millrace embankment and associated environmental concerns). We have also attached a plan view drawing of each site as well as photos.

Photo Log:

004 - Old Argo Powerhouse. This has been decommissioned and is no longer owned by the City.
018 - Argo Spillway. We are looking at placing the new powerhouse in the left embankment.
016 - Old millrace. Option Two would include placing the powerhouse at the end of the millrace.
025 - Geddes left spillway.
026 - Geddes left embankment. Proposed powerhouse location.
027 - Geddes left embankment view from downstream.
034 - Geddes Dam view from upstream.

We would like to evaluate development to three capacities; 25%, 50%, & 75% flow exceedance. The Barton and Superior sites that were previously recommissioned utilized Voest Alpine equipment.. Barton has a single vertical propeller unit (900kw) installed in an existing powerhouse and Superior has a single "S" Kaplan propeller unit (570kw) installed in a new powerhouse with siphon intake. The Superior site is very similar to Geddes with regard to head/flow.

We look forward to receiving your response to this inquiry. Please do not hesitate to contact us with any questions. As the City has us under a very tight timeline to complete our study we would appreciate an expedient response to this request.

Thanks,
<<agro_dam_embankments_11x17.tif>> <<geddes_dam_earthwork_11x17.tif>> <<Est. of Energy Production - Contractor.xls>> <<P1010004.JPG>>

<<P1010016.JPG>> <<P1010017.JPG>> <<P1010018.JPG>>
<<P1010025.JPG>> <<P1010026.JPG>> <<P1010027.JPG>> <<P1010034.JPG>>

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S-Turbines
in standardized sizes

VOITH

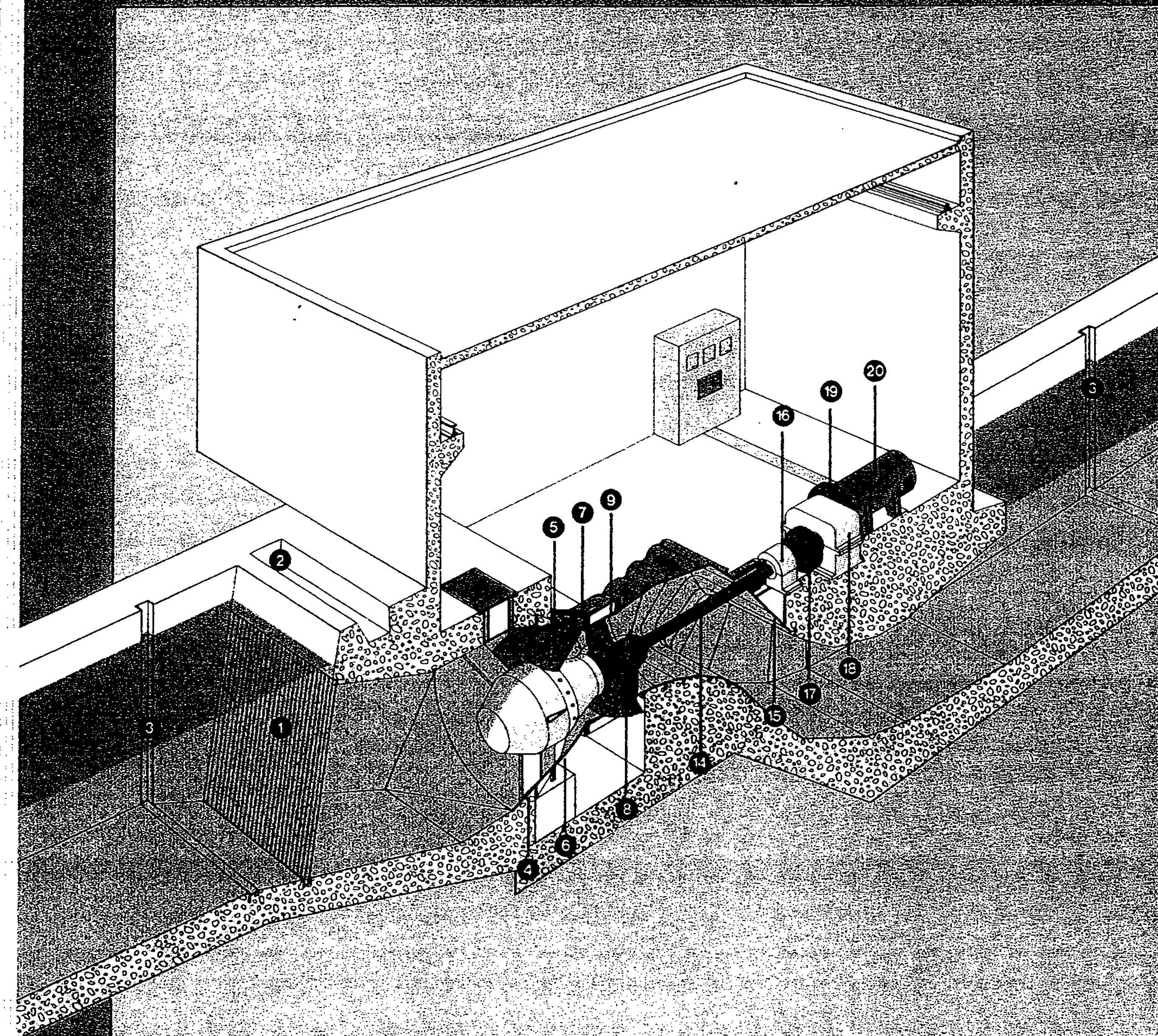


Fig. 1 (Explanation on the back page)

Voith S-Turbines

For heads up to approximately 15 (max. 25 m). For outputs up to approximately 15,000 kW.

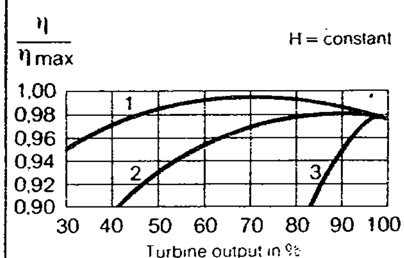
- **High energy yield, even with major fluctuations in the water supply.**
- **Small powerhouse due to compact arrangement.**
- **Depending on turbine size and transport facilities the turbine is delivered to the site in subassemblies, thus reducing installation time.**
- **Anchorage of the turbine at the intake.**
- **Thrust bearing and oil supply for the runner blade adjustment in the intake bulb.**
- **Economical, standardized gear units and generators are used.**
- **The turbines are supplied in three arrangements:**
  1.) Runner blades and wicket gates regulated. (standard design)
  2.) Runner blades regulated, wicket gates fixed.
  3.) Runner blades fixed, wicket gates regulated.

Efficiency and Output

1. Runner blades and wicket gates regulated:
Thanks to the flat efficiency curve this type of turbine can be operated economically down to low partial load, between at least 30% and 100% output. This means maximum utilization of the water supply.

2. Runner blades regulated – wicket gates fixed:
Economical application is guaranteed for normal fluctuations in the water supply (normally between 40% and 100% output). This design requires an additional shutoff device to shut down the turbine.

Efficiency characteristic



1 Runner and wicket gates regulated
2 Runner regulated, wicket gates fixed
3 Runner fixed, wicket gates regulated

3. Runner blades fixed – wicket gates regulated:
Economical solution with limited fluctuation in discharge.

The hydraulic shape of the Voith S-turbine has been optimized by extensive model tests conducted in Voith's research and development center. High efficiency can therefore be guaranteed. With an optimum discharge, turbine efficiencies of 92% and above can be achieved.

The guaranteed efficiency is dependent on the size of the turbine and the operating range.

Selection diagrams of S-t
various tailwater level ele

Turbine Rating (exact rating on request).

Application of diagram
Example:
Net head 10 m
Water discharge 21 m^3/s
Tailwater level at the elevation of the center line of the turbine shaft.

- Turbine size
  The intersection of lines 10 m and 21 m^3/s in diagram B lies in the range of turbine size 19.0 (= runner diameter in dm)
- Speed
  The speed (rpm) is calculated by the following equation:

$$\text{Speed} = \frac{\text{Kn} \times \sqrt{\text{net head}}}{\text{turbine size}}$$

with the net head in m and the turbine size in dm

Kn = 1,560 (runner with 4 blades)
Kn = 1,470 (runner with 5 blades)

For example:

$$n = \frac{1{,}470 \times \sqrt{10}}{19.0} = 245 \text{ rpm}$$

- Output at the turbine shaft.
  At the intersection of the lines 10 m and 21 m^3/s an output of approximately 1,830 kW can be read off.
- The generator terminal output is calculated from the output at the turbine shaft by multiplication with the gear unit efficiency (not applicable, if turbine is directly coupled with the generator) and the generator efficiency.

  Gear unit efficiency approx. 0.98
  Generator efficiency approx. 0.95

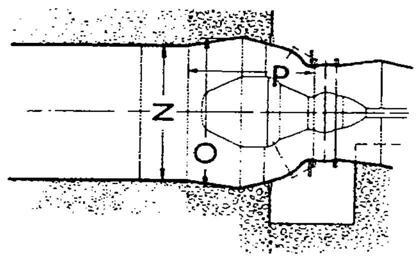
In the case of a single-regulated turbine (runner or wicket gates not adjustable) please contact any Voith manufacturing facility.

Main dimensions

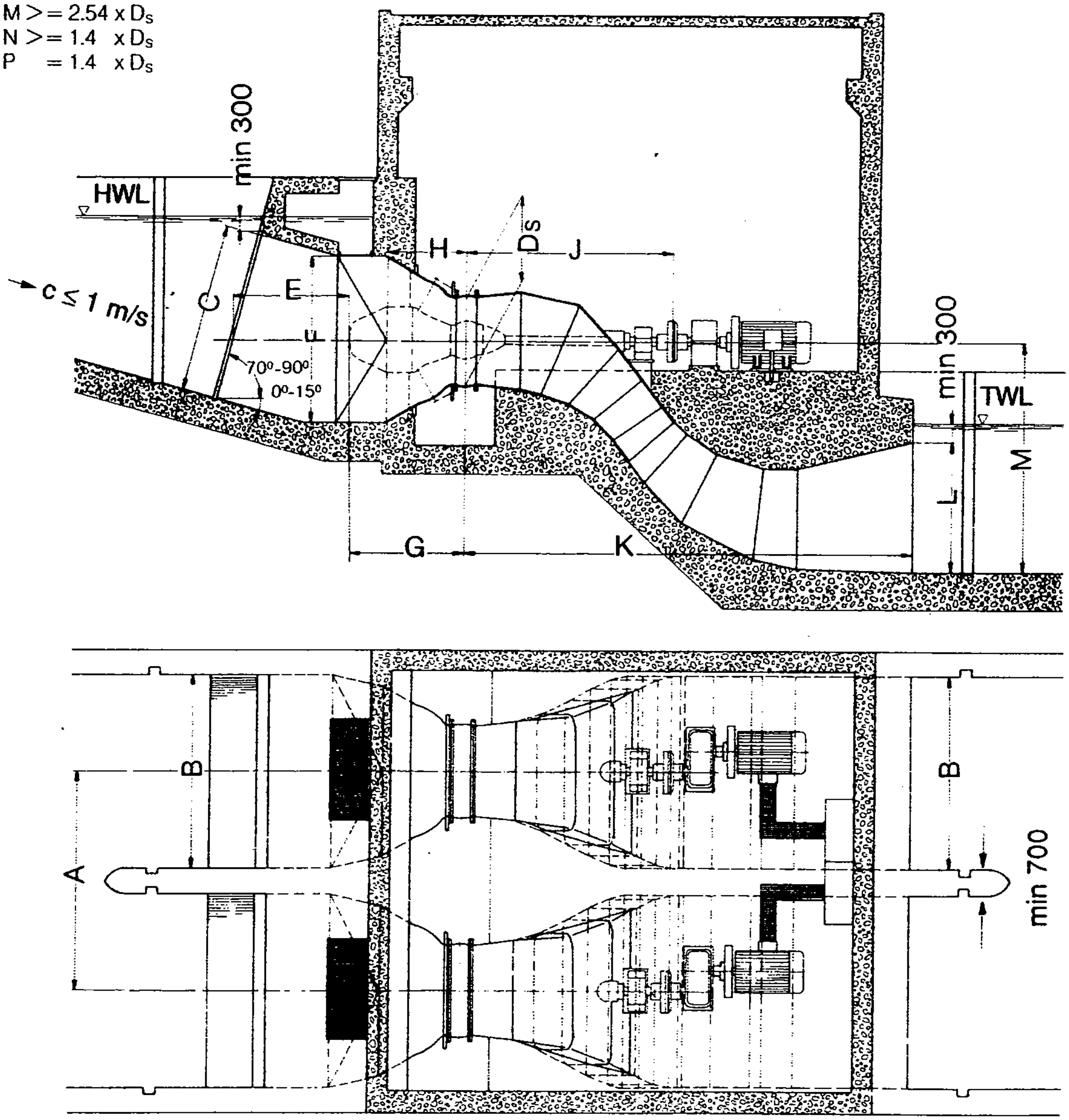
On the basis of the drawing and the table, the main dimensions of the powerhouse can be determined as a function of the turbine size. The dimensions may be subject to change for special plant conditions.

D_s = size of the turbine in dm
A $>=$ 2.5 x D_s
B $>=$ 2.15 x D_s
E $>=$ 1.0 x D_s
F $>=$ 1.9 x D_s
G $>=$ 1.5 x D_s
H $=$ 0.94 x D_s
J $>=$ 2.5 x D_s
K $>=$ 4.5 x D_s
L $>=$ 1.25 x D_s
M $>=$ 2.54 x D_s
N $>=$ 1.4 x D_s
P $=$ 1.4 x D_s

These dimensions are guidelines only. They can be adapted to the site specific conditions to optimize the power house design.



Variant of penstock connection



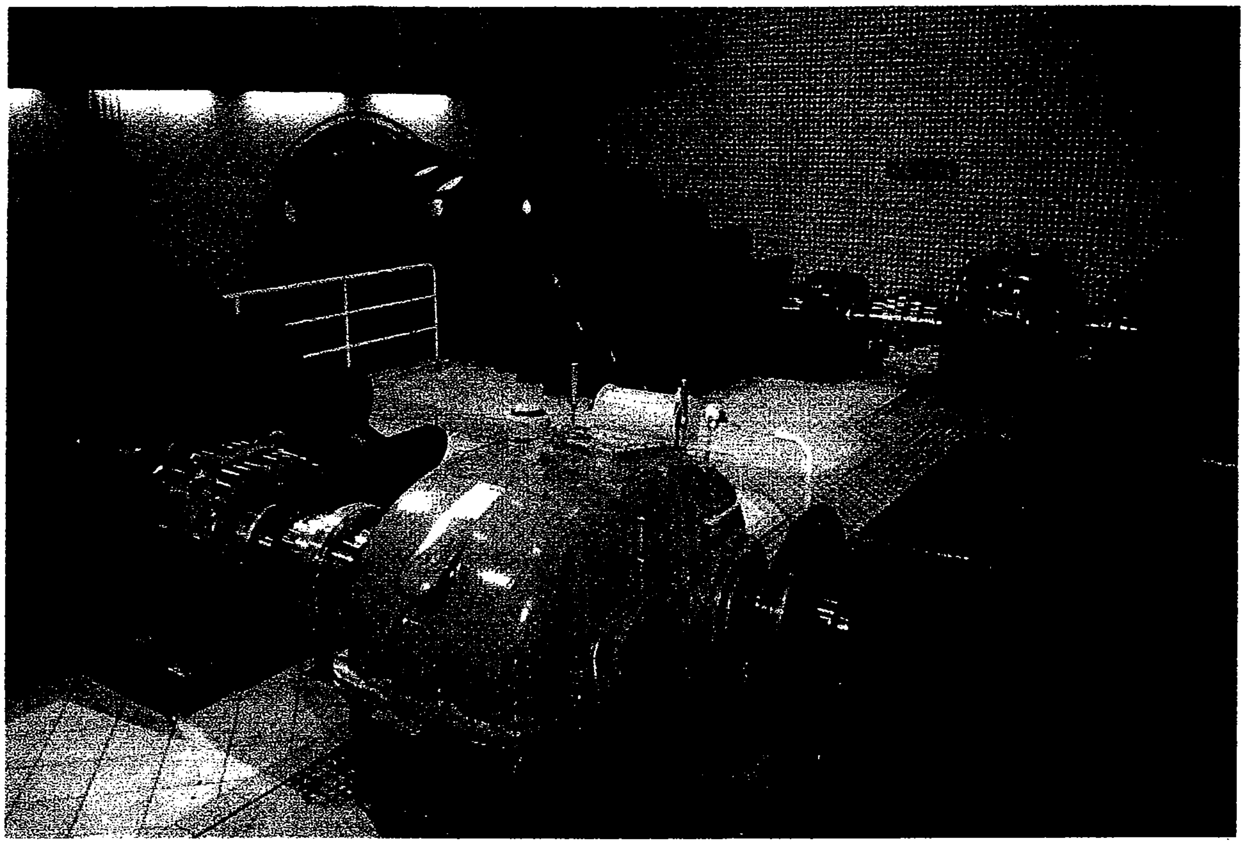
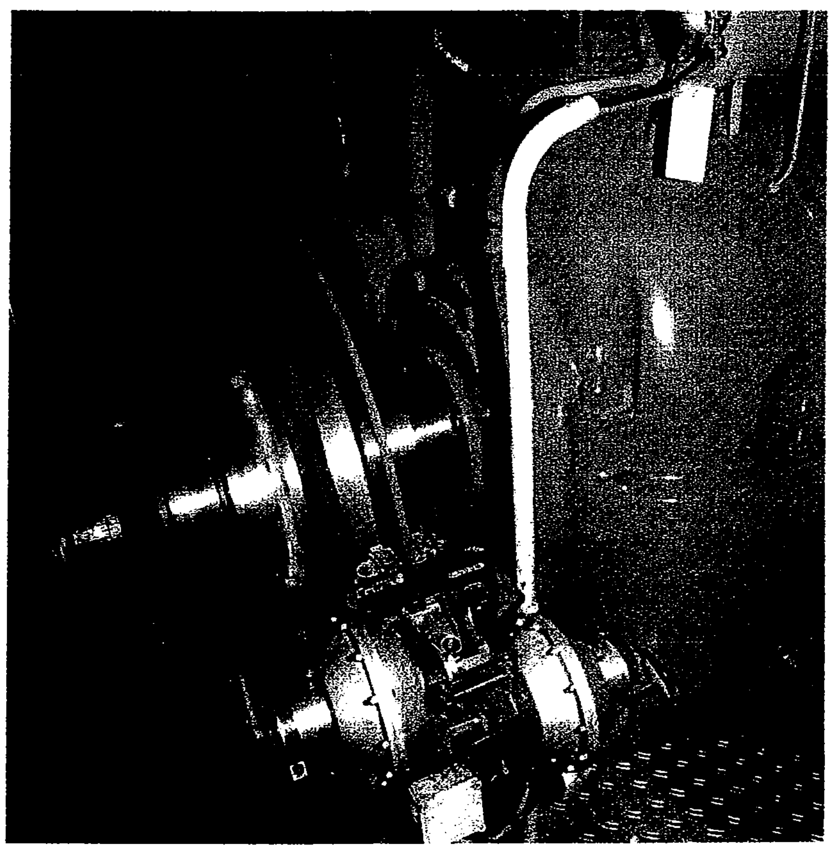


Fig. 1:
View of the interior of the "Zollhaus-wehr" power station, Federal Republic of Germany.

Fig. 2:
Coupling gear unit-generator with toothed disk for speed detection.

Fig. 3:
Coupling gear unit-generator with integrated disk brake.

2



3

bines for
tions.

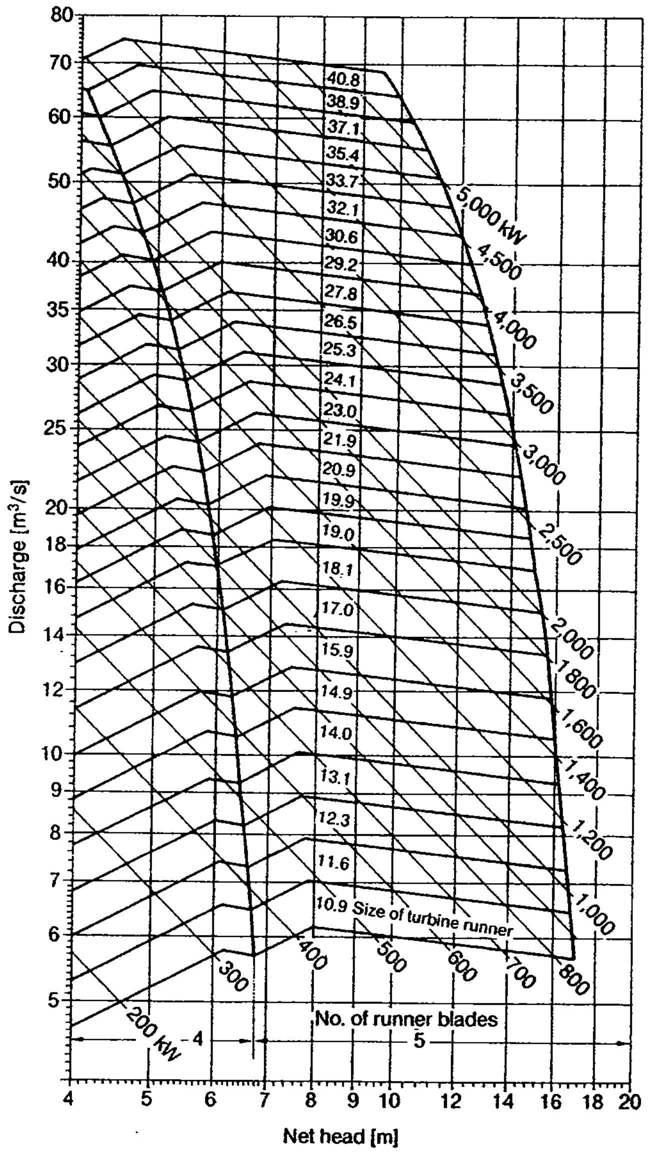


Diagram A:
Tailwater level slightly above top of the draft tube at the outlet (max. possible suction head)

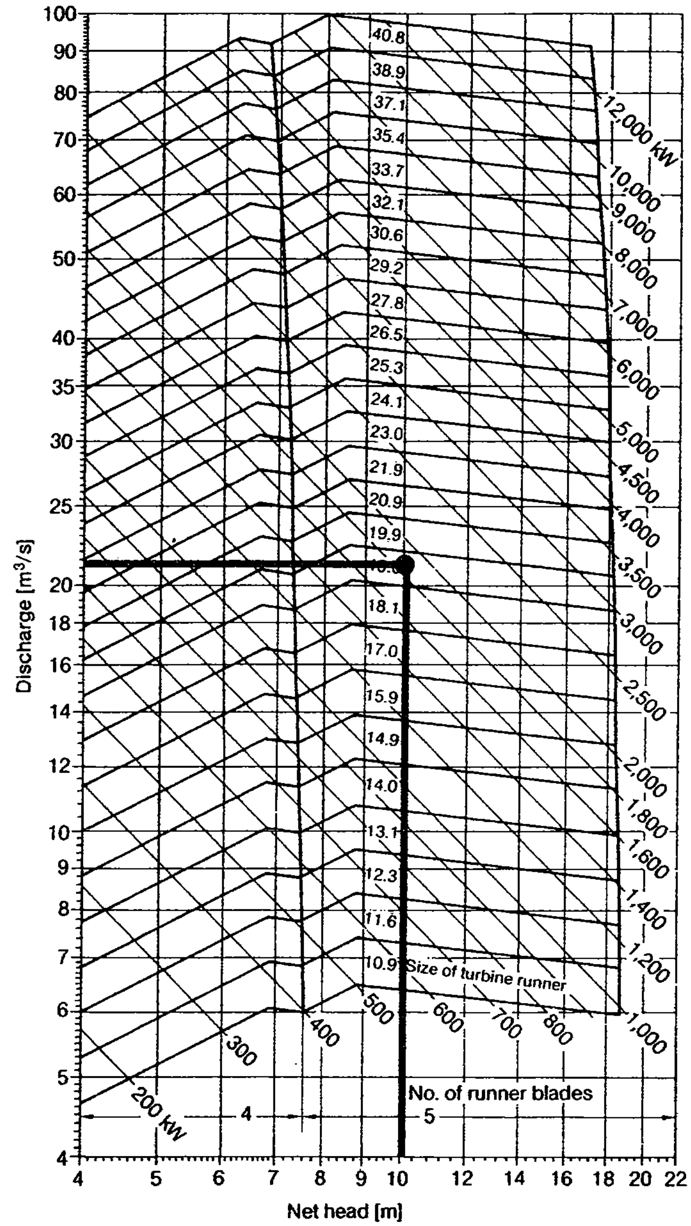


Diagram B:
Tailwater level at the elevation of the center line of the turbine shaft.

Voith Hydro Turbine Group

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Via Stendhal, 34
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Tx 353 506 rival i

VOITH
GROUP OF COMPANIES

Basic arrangement of plant

Fig. 1 on the front page shows a section through a hydroelectric power station with a horizontal double regulated Voith S-turbine.

Water first enters the turbine from the head race through the rack (1), which protects the turbine from floating debris which must be cleaned at certain intervals. Floating debris can be stored temporarily in the pit (2). After leaving the rack, the water flows through the embedded turbine supporting ring (4) into the distributor consisting of the wicket gates (5), the outer gate barrel (6) and the gate operating ring (7); the gate regulating ring (7) is operated by a servomotor.

In the runner (8), the water releases its energy and then leaves the turbine through the draft tube elbow (15), which is designed for the most efficient utilization of kinetic energy.

The runner (8) is surrounded by the discharge ring (9), which is horizontally split in the center of the shaft to simplify inspection of the runner. The turbine shaft (14), which is connected to the runner, is supported outside the draft tube (15) by a sleeve bearing (16) and connected through a flexible coupling (17) to the shaft of the gear unit. A commercial gear unit (18) may be used to step up the turbine speed to a suitable generator speed. A flexible coupling is installed between the gear unit (18) and generator (20). When a synchronous generator is used, a flywheel (19) is sometimes required to facilitate speed governoring. It is mounted on the generator shaft and is combined with a flexible coupling.

For dewatering the turbine and intake chamber for inspections, stoplogs can be inserted into the recesses (3) provided for this purpose.

With power stations incorporating a penstock, the turbine can be flange-mounted directly to the penstock.

The S-Turbines can be completely assembled at the factory and transported to the site as a compact unit. This substantially simplifies site erection and shortens installation time. Erection of the turbine is carried out either with the powerhouse crane or a mobile crane. For hydroelectric power stations equipped with 2 or more turbines, installation of a bridge crane may be economical.

Fig. 4 shows a section through the turbine. All of the turbine components described here are conveniently accessible so that inspection as well as removal and reinstallation can be accomplished with a minimum of effort. The servomotor (10) for the adjustment of the runner blades is arranged in the runner hub. It receives the pressure oil from the oil supply system (11) through the shaft. The axial thrust of the runner is absorbed by the thrust bearing (12) and transmitted a short distance through the turbine supporting ring into the building. The thrust bearing is combined with a guide bearing. The bearing is equipped with a separate oil supply system. The shaft seal (13) can be conveniently inspected and exchanged, if required.

Governing

For S-Turbines supplied by Voith, complete governing systems suitable for parallel network operation and isolated load operation are available. Separate brochures are available upon request.

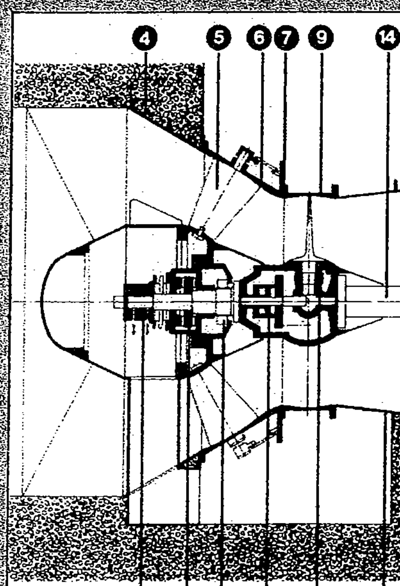


Fig. 4

Basic arrangement of plant

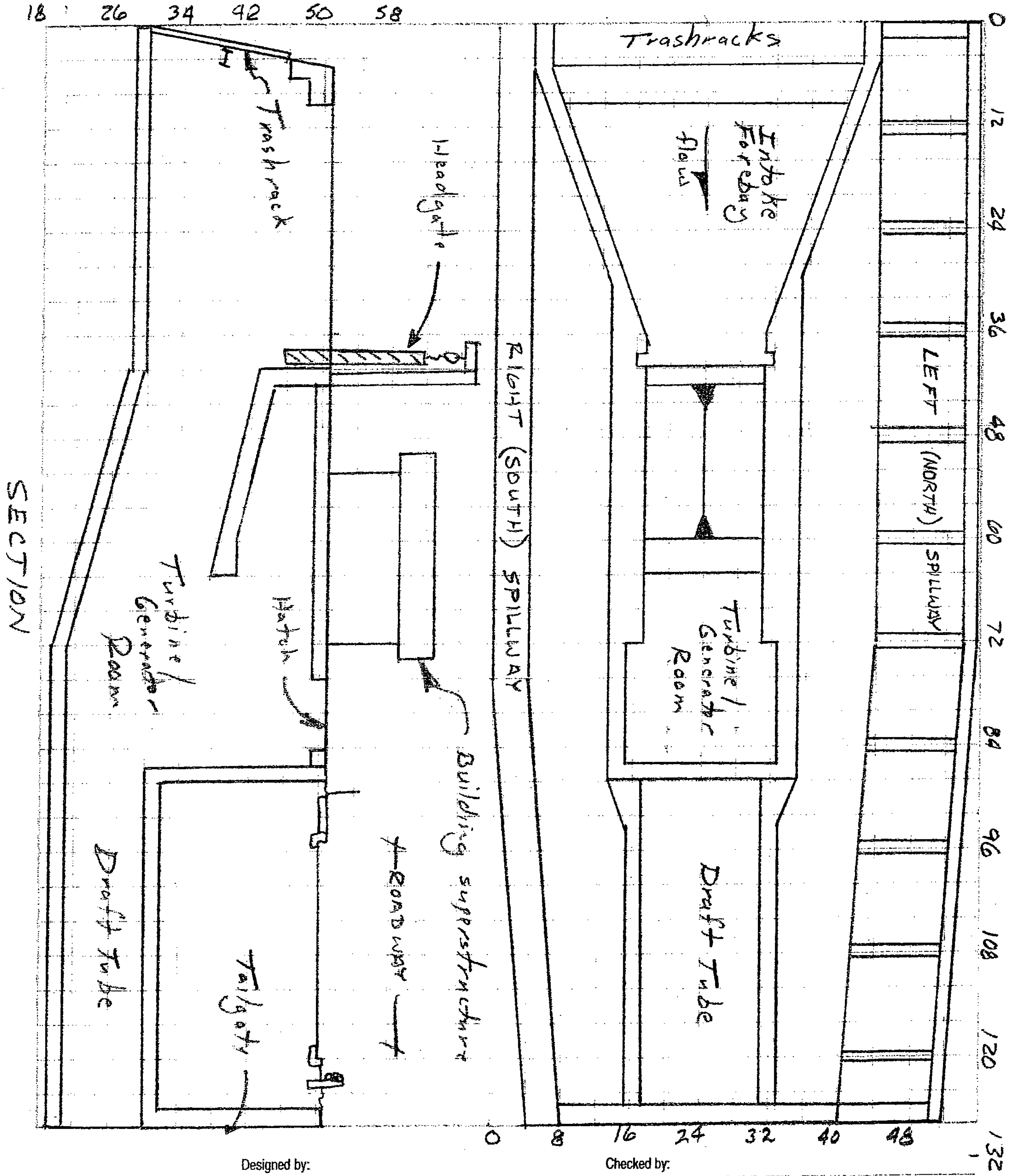
1 Intake rack
2 Pit for floating debris
3 Stoplog recess
4 Turbine supporting ring
5 Wicket gate
6 Outer gate barrel
7 Wicket gate regulating ring
8 Runner
9 Discharge ring
10 Runner servomotor
11 Oil supply system
12 Thrust and guide bearing
13 Shaft seal
14 Turbine shaft
15 Elbow draft tube
16 Guide bearing
17 Flexible coupling
18 Gear unit
19 Flywheel with flexible coupling
20 Generator

APPENDIX C
Site Layout

Stantec

Ann Arbor Hydro Feasibility
Argo & Geddes Dams
Site Layout - Geddes Dam

6/19/08



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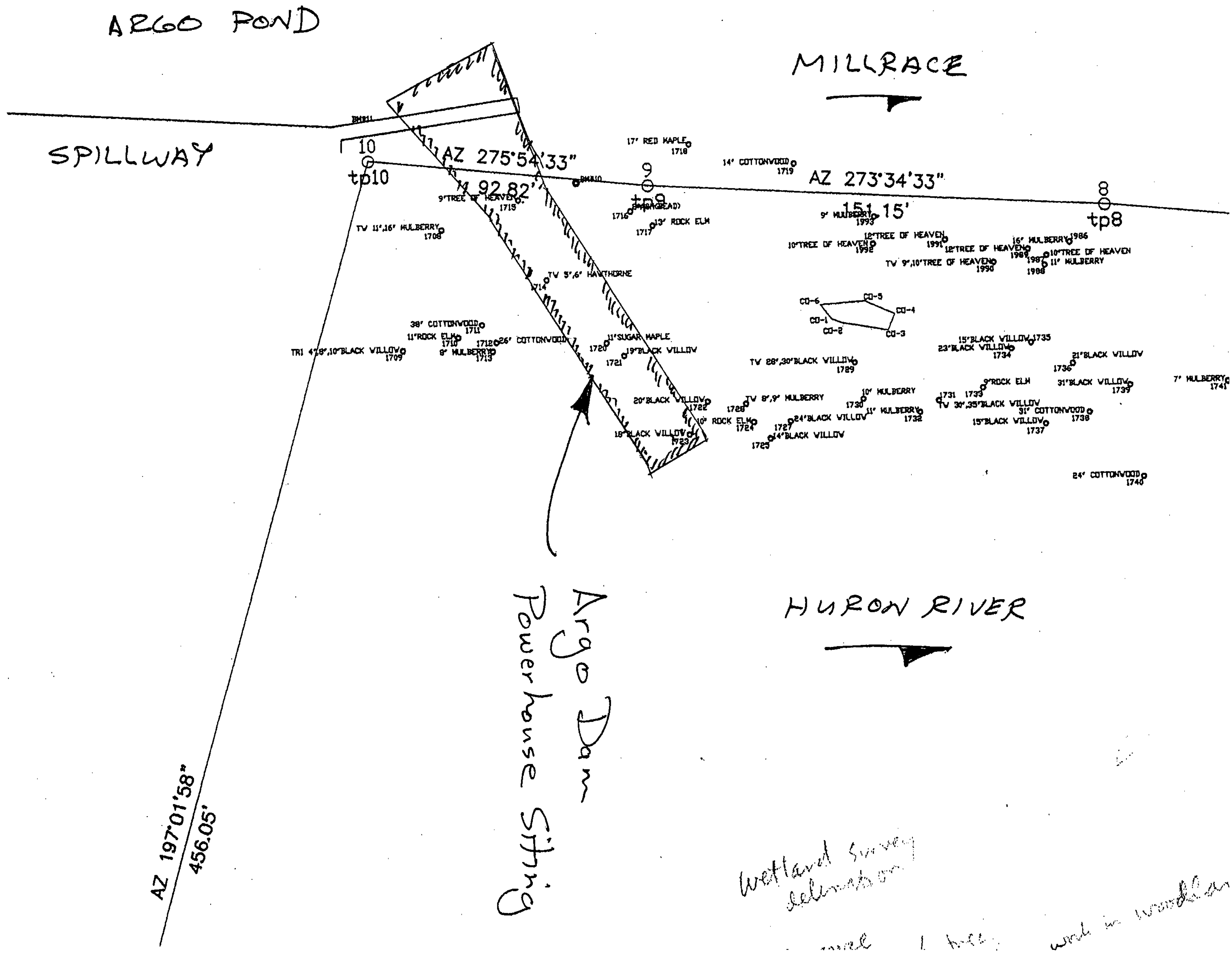


ARGO POND
SPILLWAY
MILLRACE
HURON RIVER
10
tp10
9
tp9
8
tp8
AZ 275°54'33"
92.82'
AZ 273°34'33"
151.15'
AZ 197°01'58"
456.05'
Argo Dam Powerhouse Siting
Wetland Survey delineation

APPENDIX D
Power Production Tables

Canadian Hydro Components, Ltd.

Stantec

CITY OF ANN ARBOR
HYDROELECTRIC FEASIBILITY STUDY
ESTIMATE OF ANNUAL ENERGY PRODUCTION
ARGO DAM - OPTION 1 (Powerhouse at dam)
Project No.: 2075109900

Flow Exceedance (%)	Flow Rate (CFS)	Headwater Elevation (USGS)	Tailwater Elevation (USGS)	Gross Head (FT)	Net Head (FT)	Unit Efficiency (%)	Unit Output (kW)	Total Output (kWH)
90	120	774.0	762.2	11.8	11.3	82%	94	82,546
80	160	774.0	762.4	11.6	11.1	84%	126	110,750
70	210	774.0	762.5	11.5	11.0	86%	168	147,480
60	260	774.0	762.6	11.4	10.9	87%	209	183,038
50	330	774.0	762.8	11.2	10.7	86%	257	225,433
40	420	774.0	763.1	10.9	10.4	86%	318	278,871
30	520	774.0	763.4	10.6	10.1	84%	374	327,511
20	536	774.0	763.7	10.3	9.8	84%	374	327,561
10	536	774.0	764.0	10.0	9.5	84%	362	317,534
0	536	774.0	764.5	9.5	9.0	84%	343	300,821
Estimated Total Annual Energy Production (KWH)								2,301,545

Reduce estimate by 3% for transformer losses and station power	**-69,046**
Reduce estimate by 10% for miscellaneous downtime	**-230,155**
Net Estimated Total Annual Energy Production (KWH)	**2,002,344**

Stantec

CITY OF ANN ARBOR
HYDROELECTRIC FEASIBILITY STUDY
ESTIMATE OF ANNUAL ENERGY PRODUCTION
ARGO DAM - OPTION 2 (Powerhouse at end of millrace)
Project No.: 2075109900

Flow Exceedance (%)	Flow Rate (CFS)	Headwater Elevation (USGS)	Tailwater Elevation (USGS)	Gross Head (FT)	Net Head (FT)	Unit Efficiency (%)	Unit Output (KW)	Total Output (KWH)
90	120	774.0	760.2	13.8	13.3	82%	111	97,156
80	160	774.0	760.4	13.6	13.1	83%	147	129,149
70	210	774.0	760.5	13.5	13.0	85%	197	172,268
60	260	774.0	760.6	13.4	12.9	86%	244	214,133
50	330	774.0	760.8	13.2	12.7	87%	309	270,682
40	420	774.0	761.1	12.9	12.4	86%	380	332,500
30	520	774.0	761.4	12.6	12.1	84%	447	391,898
20	594	774.0	761.7	12.3	11.8	84%	499	437,089
10	594	774.0	762.0	12.0	11.5	84%	486	425,977
0	594	774.0	762.5	11.5	11.0	84%	465	407,456
Estimated Total Annual Energy Production (KWH)								2,878,306

Reduce estimate by 3% for transformer losses and station power -86,349

Reduce estimate by 10% for miscellaneous downtime -287,831

Net Estimated Total Annual Energy Production (KWH) 2,504,126

Stantec

CITY OF ANN ARBOR
HYDROELECTRIC FEASIBILITY STUDY
ESTIMATE OF ANNUAL ENERGY PRODUCTION
GEDDES DAM
Project No.: 2075109900

Flow Exceedance (%)	Flow Rate (CFS)	Headwater Elevation (USGS)	Tailwater Elevation (USGS)	Gross Head (FT)	Net Head (FT)	Unit Efficiency (%)	Unit Output (KW)	Total Output (KWH)
90	140	747.5	731.0	16.5	16.0	82%	156	136,359
80	180	747.5	731.2	16.3	15.8	84%	202	177,350
70	220	747.5	731.2	16.3	15.8	85%	250	219,341
60	280	747.5	731.2	16.3	15.8	86%	322	282,446
50	350	747.5	731.3	16.2	15.7	86%	400	350,823
40	430	747.5	731.4	16.1	15.6	86%	489	428,266
30	550	747.5	731.6	15.9	15.4	85%	610	534,471
20	633	747.5	731.9	15.6	15.1	83%	672	588,953
10	633	747.5	732.2	15.3	14.8	83%	659	577,252
0	633	747.5	732.5	15.0	14.5	83%	646	565,551
Estimated Total Annual Energy Production (KWH)								3,860,814

Reduce estimate by 3% for transformer losses and station power	**-115,824**
Reduce estimate by 10% for miscellaneous downtime	**-386,800**
Net Estimated Total Annual Energy Production (KWH)	**3,358,190**

HTS, Inc.
(Ossberger)

Stantec

CITY OF ANN ARBOR
HYDROELECTRIC FEASIBILITY STUDY
ESTIMATE OF ANNUAL ENERGY PRODUCTION
ARGO DAM - OPTION 1 (Powerhouse at dam)
Project No.: 2075109900

Flow Exceedance (%)	Flow Rate (CFS)	Headwater Elevation (USGS)	Tailwater Elevation (USGS)	Gross Head (FT)	Net Head (FT)	Unit Efficiency (%)	Unit Output (kW)	Total Output (kWH)
90	120	774.0	762.2	11.8	11.3	64%	74	64,426
80	160	774.0	762.4	11.6	11.1	77%	116	101,521
70	210	774.0	762.5	11.5	11.0	81%	159	138,905
60	260	774.0	762.6	11.4	10.9	82%	197	172,519
50	330	774.0	762.8	11.2	10.7	83%	248	217,569
40	420	774.0	763.1	10.9	10.4	84%	311	272,386
30	520	774.0	763.4	10.6	10.1	84%	374	327,511
20	670	774.0	763.7	10.3	9.8	82%	456	399,702
10	733	774.0	764.0	10.0	9.5	82%	484	423,900
0	733	774.0	764.5	9.5	9.0	81%	453	396,692
Estimated Total Annual Energy Production (KWH)								2,515,132

Reduce estimate by 3% for transformer losses and station power	**-75,454**
Reduce estimate by 10% for miscelleous downtime	**-251,513**
Net Estimated Total Annual Energy Production (KWH)	**2,188,165**

Stantec

CITY OF ANN ARBOR
HYDROELECTRIC FEASIBILITY STUDY
ESTIMATE OF ANNUAL ENERGY PRODUCTION
ARGO DAM - OPTION 2 (Powerhouse at end of millrace)
Project No.: 2075109900

Flow Exceedance (%)	Flow Rate (CFS)	Headwater Elevation (USGS)	Tailwater Elevation (USGS)	Gross Head (FT)	Net Head (FT)	Unit Efficiency (%)	Unit Output (KW)	Total Output (KWH)
90	120	774.0	760.2	13.8	13.3	64%	86	75,237
80	160	774.0	760.4	13.6	13.1	77%	137	120,124
70	210	774.0	760.5	13.5	13.0	81%	187	163,958
60	260	774.0	760.6	13.4	12.9	82%	234	204,920
50	330	774.0	760.8	13.2	12.7	84%	297	259,792
40	420	774.0	761.1	12.9	12.4	85%	373	326,700
30	520	774.0	761.4	12.6	12.1	84%	447	391,898
20	636	774.0	761.7	12.3	11.8	82%	520	455,737
10	636	774.0	762.0	12.0	11.5	82%	506	443,065
0	636	774.0	762.5	11.5	11.0	81%	483	422,762
Estimated Total Annual Energy Production (KWH)								2,864,194

Reduce estimate by 3% for transformer losses and station power	**-85,926**
Reduce estimate by 10% for miscellaneous downtime	**-286,419**
Net Estimated Total Annual Energy Production (KWH)	**2,491,849**

Stantec

CITY OF ANN ARBOR
HYDROELECTRIC FEASIBILITY STUDY
ESTIMATE OF ANNUAL ENERGY PRODUCTION
GEDDES DAM
Project No.: 2075109900

Flow		Headwater Elevation (USGS)	Tailwater Elevation (USGS)	Gross Head (FT)	Net Head (FT)	Unit Efficiency (%)	Unit Output (KW)	Total Output (KWH)
Exceedance (%)	Rate (CFS)							
90	140	747.5	731.0	16.5	16.0	64%	121	106,427
80	180	747.5	731.2	16.3	15.8	72%	174	152,014
70	220	747.5	731.2	16.3	15.8	77%	227	198,698
60	280	747.5	731.2	16.3	15.8	81%	304	266,025
50	350	747.5	731.3	16.2	15.7	84%	391	342,664
40	430	747.5	731.4	16.1	15.6	84%	478	418,306
30	550	747.5	731.6	15.9	15.4	84%	603	528,183
20	696	747.5	731.9	15.6	15.1	82%	730	639,767
10	696	747.5	732.2	15.3	14.8	82%	716	627,057
0	696	747.5	732.5	15.0	14.5	81%	693	606,854
Estimated Total Annual Energy Production (KWH)								**3,885,996**

Reduce estimate by 3% for transformer losses and station power	**-116,580**
Reduce estimate by 10% for miscellaneous downtime	**-388,600**
Net Estimated Total Annual Energy Production (KWH)	**3,380,816**

APPENDIX E
Historical Power Production
(Barton and Superior)

Power Generation (MW)

Barton

Month	FY86	FY87	FY88	FY89	FY90	FY91	FY92	FY93
		86 Calendar year	87	88	89	90	91	92
July	0	341.97	69.855	35.775	393.21	231.555	0	415.3304
Aug	0	112.38	84.375	134.97	181.455	194.655	0	493.6119
Sept	0	294.66	266.19	206.835	417.51	412.965	0	595.994
Oct	0	529.755	265.755	385.335	297.045	607.545	252.825	566.904
Nov	0	521.04	496.77	623.085	556.365	648.99	484.92	179.1107
Dec	0	619.92	683.55	612.69	427.545	660.36	654.57	0
Jan	0	501.945	618.045	622.605	655.125	676.47	598.155	279.2288
Feb	0	460.23	591.99	448.56	608.79	600.33	541.89	622.859
Mar	0	664.395	686.82	535.365	630.045	666.105	457.92	674.9996
Apr	221.04	563.43	604.8	629.625	652.665	621.735	552.12	658.5641
May	424.59	281.865	291.435	427.41	641.16	586.485	479.58	548.7852
Jun	209.42	179.325	35.625	649.875	412.95	224.325	327.21	561.3772
		3275	4517	4826	5587	6356	4768	5202

Superior

Month	FY86	FY87	FY88	FY89	FY90	FY91	FY92	FY93
July	0	140.01	59.8	43.81	0	0	38	24.6325
Aug	0	103.9	16.37	122.27	0	0.56	60	0
Sept	0	162.75	183.85	147.06	0	180.08	0	0
Oct	0	359.94	190.5	254.39	0	355.3	14.35	0
Nov	0	296.05	293.73	355.17	0	384.35	47.37	247.7734
Dec	0	449.47	392.88	40.5	0	399.2	426.55	440.4893
Jan	0	357.34	410.16	0	0	414.38	388.72	395.167
Feb	0	290.02	403.93	109.84	0	367.67	361.52	390.875
Mar	0	404.69	398.34	244.4	0	353.06	439.62	375.035
Apr	0	336.29	360.06	0	0	268.1	388.04	409.5012
May	0	203.09	0	0	0	368.91	371.92	371.5368
Jun	0	116.44	0	0	0	232.31	188.43	342.3964
			2845	2532	354	1318	2678	2846

Barton

93	94	95	96	97	98	99	00	01
FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
349.2	409.9254	389.3254	0	0	166.88	253.19	498.694	105.259
184.83	367.9036	442.9509	0	0	0	12.95	601.096	114.744
175.755	232.3729	31.1728	89.5473	213.307	0.07	0	495.71	182.356
0	392.8503	0	267.6587	354.515	105.77	0	540.686	559.441
101.16	421.6989	0	137.2808	258.865	292.32	248.22	550.9	626.101
438.39	517.9071	0	0.0002	605.588	319.27	363.44	558.049	678.306
333.09	538.9329	0	0	699.291	386.54	295.68	548.701	578.792
451.095	427.3996	0	0	607.51	1063.93	460.46	589.861	613.234
666.45	552.2141	0	0	669.69	1083.88	634.41	569.91	659.741
639.585	529.9708	2.4816	0	655.639	1061.06	696.08	566.451	628.624
529.98	610.5676	0	0	476.99	784	1121.54	547.259	597.851
279.075	362.7348	0	0	319.756	325.43	1051.61	555.121	279.414
4589	5306	3884	585	1238	4307	5232	7499	5144

Superior

FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
283.55	0	164.2078	207.4386	201.048	122.8	110.16	302.611	0
0	0	217.517	78.389	207.699	48.08	26.68	343.632	0
0	0	63.867	38.6266	268.142	0	7.68	329.012	0
0	0	143.9294	161.0755	235.439	0	9.52	296.199	0
0	0	295.712	210.534	166.49	163.84	1.24	233.28	0
130.81	0	356.9537	292.1134	331.715	69.84	256.56	363.29	0
164.29	0	332.8367	386.915	402.803	114.36	228.16	360.128	0
0	67.3494	282.2492	293.5211	323.241	584.68	409.52	296.079	0
299.4	416.9757	349.4671	200.2772	337.534	672.76	476.28	388.437	0
394.18	383.6275	291.5188	391.9962	368.295	395.44	477.28	35.206	205.601
290.13	418.9296	357.6684	408.3952	291.472	408.32	505.12	0	396.237
0	180.5667	332.2519	320.451	219.054	38.84	207.76	0	228.963
2695	1147	2708	2935	3406	2348	2626	4174	1080

02	03	04	05	06
FY03	FY04	FY05	FY06	FY07
279.414	69.122	483.886	0	270.883
0	0.966	348.525	0	133.83
0	3.671	0	0	310.038
0.082	130.484	0	0	497.219
177.112	427.971	0	0.217	597.31
198.878	477.839	0	201.347	670.251
226.905	451.048	0	260.588	669.82
178.439	324.769	0	610.512	441.033
430.229	606.763	0	668.484	621.208
524.069	0	0	629.161	647.538
547.566	310.147	0	617.093	599.221
346.501	507.491	0	447.548	465.586
4008	3354	3029	201	5708

88613/21 4220/yr

FY03	FY04	FY05	FY06	FY07
228.963	10.396	339.67	0	0
9.639	1.229	287.722	0	0
0	8.114	79.478	0.04	0.237
7.946	12.199	46.168	0	282.083
134.753	212.896	294.671	39.646	264.551
144.05	332.966	371.644	235.485	364.272
131.2	324.163	318.027	322.609	313.519
136.876	270.22	340.764	344.559	302.112
249.102	391.754	384.3	389.93	347.427
215.967	161.23	150.369	378.877	303.953
102.584	113.406	280.288	367.392	327.906
0	216.551	58.67	5.464	249.814
1355	1414	2897	1806	2720

45,884/20 2294/yr

APPENDIX F
FERC License Information

Industries

Hydropower - Regulation

Origin of Hydroelectric Regulation

Hydroelectric power regulation was the first work undertaken by the Federal Power Commission, the Commission's predecessor, after Congress passed the Federal Water Power Act of 1920.

Subsequent statutes under which the Commission regulates non-federal hydroelectric power projects that affect navigable waters, occupy U.S. lands, use water or water power at a government dam, or affect the interests of interstate commerce include the FPA (Federal Power Act), the PURPA (Public Utility Regulatory Policies Act), the Electric Consumers Protection Act of 1986, and the EPAct (Energy Policy Act of 1992).

This work includes: Issuing preliminary permits, project licenses and exemptions from licensing; ensuring dam safety; performing project compliance activities; investigating and assessing payments for headwater benefits; and coordinating with other agencies.

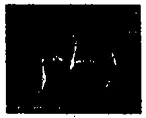
Licenses are issued for a term of between 30 to 50 years, and exemptions are granted in perpetuity. Commission costs are offset by annual charges collected from license and exemption holders. The Commission also determines charges for a licensee's use of federal lands, federal dams, and Native American reservations.

Licensed projects receive comprehensive safety inspections from Commission engineers stationed in Washington and at five regional offices. The Commission is responsible for dam safety at over 2,600 licensed and exempted dams and related water retention structures. The dam safety program is a key Commission priority.

Updated: June 13, 2003

Developing Small/Low-Impact Hydropower Projects

The Federal Energy Regulatory Commission (FERC) is experiencing increased interest from those seeking to develop small/low-impact hydropower projects. This brochure explains how best to obtain Commission authorization to construct and operate these small/low-impact projects while assuring adequate protection of environmental resources. Benefits of developing these projects include:



- Emission-free renewable source of energy
- Low impacts to environmental resources
- Financial incentives to developers under state Renewable Portfolio Standards

FERC's Role

Under the Federal Power Act, FERC is charged with the authorization and regulation of the nation's non-federal hydropower resources. FERC issues three types of authorizations:

- **License** – Issued for 30- to 50-year terms. Must be renewed. Gives the licensee the power of "eminent domain" to obtain lands or other rights needed to construct, operate, and maintain the hydroelectric project.
- **5 Megawatt (MW) Exemption** – Issued in perpetuity. Must be located at the site of an existing dam or use a natural water feature. Must propose increased capacity. The exemptee must own all lands and facilities other than federal lands to be eligible.
- **Conduit Exemption** – Issued in perpetuity. Must use the potential of a conduit constructed primarily for non-hydropower purpose. The exemptee must own the proposed powerhouse and the lands upon which the powerhouse will be located. A conduit exemption may not use federal lands.

General Process for License and Exemption Applications

Getting started

- Contact FERC staff to get advice on the best way to obtain authorization for your project (1-866-914-2849 or smallhydro@ferc.gov)

Pre-filing consultation and initial project review

- Gather needed information to identify project-related effects
- Send package describing your proposal and environmental effects to Commission staff, all relevant government and tribal agencies, and non-government and public entities
- Meet with all affected agencies and entities to explain your proposal and to request input
- Determine whether and to what degree affected agencies and entities are willing to expedite the consultation process or forego a consultation stage
- Apply for and obtain a state Water Quality Certification or waiver
- Prepare and file a license or exemption application

Application processing

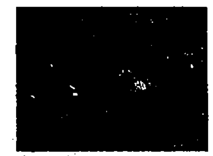
- Commission staff requests comments on application from all interested agencies and entities
- Commission staff conducts comprehensive project review, including issuing environmental document (not usually required for conduit exemption)
- Commission acts on application

How FERC May Expedite the Process

- With resource agency cooperation, waive some pre-filing consultation requirements
- Combine scoping of issues with pre-filing consultation
- Combine public noticing requirements
- Shorten comment periods
- Use a single environmental document in lieu of draft and final documents

Factors that Reduce Time and Cost

- Project at existing dam
- Little change to water flow and use
- Unlikely to: affect threatened and endangered species; or need fish passage
- Applicant owns all lands needed for project construction and operation
- Information on existing environmental resources and project effects readily available
- A complete application that addresses all issues



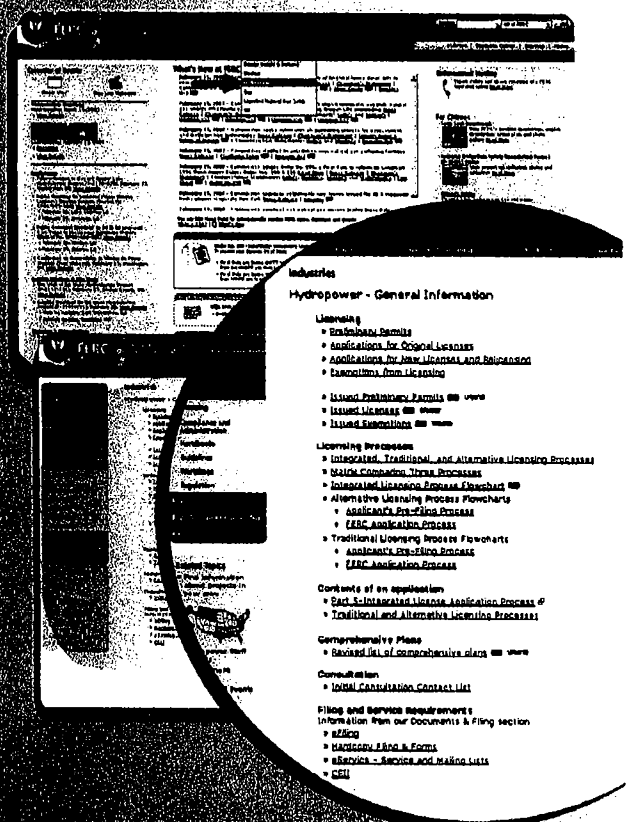
Examples of Successfully Expedited Projects

- Lower Turnbull Drop Project No. 12597 (5.0 MW); Upper Turnbull Drop Project No. 12598 (4.1 MW); Mill Coulee Drops Project No. 12599 (1.05 MW) licenses issued (07/28/06) 8 months from filing
- Corriveau Project No. 12629 (350 kW) exemption issued (10/24/06) 10 months from filing

Guidance on the Internet

To access guidance on small hydropower development:

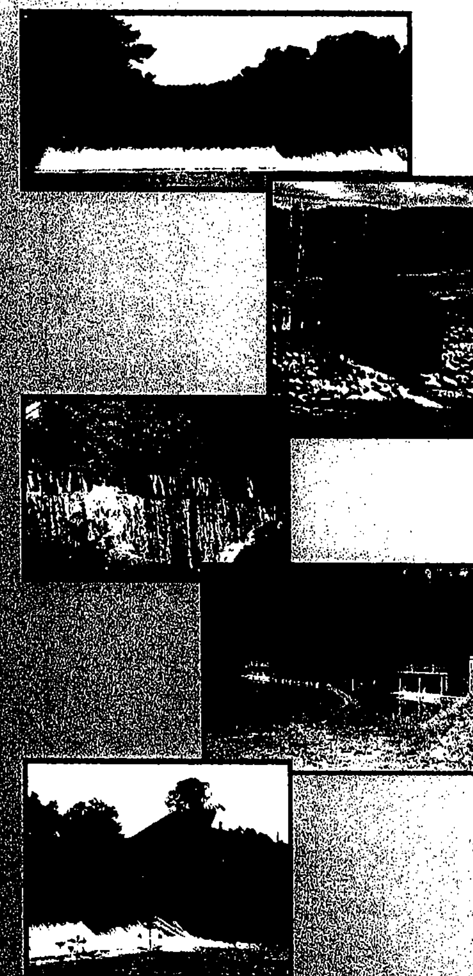
- Point your browser to www.ferc.gov
- Using the drop down menu from the fifth navy blue tab, **Industries**, select **Hydropower**.
- Scroll to the bottom of the page and click on **General Information** in the lower right hand corner.
- Click on **Licensing**.



For further assistance please contact us at:
[illegible] 2849 or smallhydro@ferc.gov

Federal Energy Regulatory Commission
888 First St., N.E.
Washington, D.C. 20426

Guide to Developing Small/Low-Impact Hydropower Projects



Federal Energy Regulatory Commission

stantec.com

Memo

Stantec

To: File | From: Dana M Dougherty, P.E.

File: 207509900 | Date: May 19, 2008

Reference: Ann Arbor Hydro Feasibility – Telecom with Hank Ecton, FERC

We discussed FERC license jurisdiction. Hank indicated the following:

1. FERC, if requested, will perform a jurisdictional review at no charge.
2. Items that dictate jurisdiction are stream navigability, history of interstate commerce, and date of construction (1935).
3. The owner/applicant must file a Declaration of Intent with FERC to initiate their determination. It will typically take FERC 90-120 days to issue a determination.
4. Hank confirmed that loads would need to be separated ie. "Off Grid" to meet non-interstate commerce classification.

Stantec Consulting Michigan, Inc.

Industries

Hydropower - Compliance and Administration

Jurisdiction Determination

Section 23(b)(1) of the Federal Power Act requires an entity to either file a hydropower license application for a proposed project or file a Declaration of Intention with the Commission to determine if the proposed project requires licensing. If the hydropower project is operating, the operator should file a Petition for Declaratory Order.

The following guide and regulation are provided below to assist you in filing your Declaration of Intention or Petition for Declaratory Order.

- » Part 24 of FERC's Regulations PDF
- » An outline of the required filing PDF

Please submit an original and 8 copies of your Declaration of Intention or Petition for Declaratory Order with the:

Secretary
Federal Energy
Regulatory Commission
888 First Street, N.E.

Contact Information

Henry Ecton
Telephone: 202-502-8768
Email: henry.ecton@ferc.gov

Additional Information

- » Standard L, E, & P Form Articles
- » Jurisdiction Determination
- » Headwater Benefits
- » Renewable Energy Tax Credit Guidelines Pursuant to the Energy Policy Act of 2005 PDF

Washington, DC 20426

Updated: May 2, 2005

schedule, must comply with the requirements of §16.8 and part 6 of this chapter, and must provide for disposition of any project facility.

PART 20—AUTHORIZATION OF THE ISSUANCE OF SECURITIES BY LICENSEES AND COMPANIES SUBJECT TO SECTIONS 19 AND 20 OF THE FEDERAL POWER ACT

AUTHORITY: Secs. 3(16), 19, 20, 41 Stat. 1063, 1073; secs. 201, 309, 49 Stat. 838, 858; 16 U.S.C. 796 (16), 812, 813, 825k.

SOURCE: Order 170, 19 FR 2013, Apr. 8, 1954, unless otherwise noted.

§20.1 Applicability.

(a) *Without special proceeding for regulation.* Every security issue within the scope of the jurisdiction conferred upon the Commission by sections 19 and 20 of the Federal Power Act shall be subject to the provisions of §20.2, except a security issue by a person organized and operating in a State under the laws of which its security issues are regulated by a State commission, or by any one described in subsection 201(f) of the act. No other security issue within the scope of sections 19 and 20 shall be subject to §20.2 except as provided in paragraph (b) of this section.

(b) *Reservation of possibility of regulation in other cases.* Not later than 10 days prior to any proposed security issuance which is within the scope of section 19 or section 20 of the act, but excepted by paragraph (a) of this section, any person or state entitled to do so under section 19 or section 20, may file a complaint or request in accordance with the applicable rules of the Commission, or the Commission upon its own motion may by order initiate a proceeding, raising the question whether issuance of such security should be subjected by Commission order to the provisions of §20.2. After notice of such filing or order, and until such request or complaint is denied or dismissed or the proceeding initiated by such order is terminated without subjecting the issuance of the security to the provisions of §20.2, the security in question shall not be issued except it be issued subject to and in compliance with §20.2.

§20.2 Regulation of issuance of securities.

The licensee or other person issuing or proposing to issue any security subjected to this section by or pursuant to §20.1, shall be subject to and shall comply with the same requirements as the Commission would administer to it if it were a public utility issuing the security within the meaning and subject to the requirements of section 204 of the Act and part 34 of this subchapter.

CROSS REFERENCE: For applications for authorization of the issuance of securities or the assumption of liabilities, see part 34 of this chapter.

PART 24—DECLARATION OF INTENTION

AUTHORITY: 16 U.S.C. 791a-825r; 44 U.S.C. 3501 *et seq.*; 42 U.S.C. 7101-7352.

§24.1 Filing.

An original and eight conformed copies of each declaration of intention under the provisions of section 23(b) of the Act shall be filed. The declaration shall give the name and post office address of the person to whom correspondence in regard to it shall be addressed, and shall be accompanied by:

(a) A brief description of the proposed project and its purposes, including such data as maximum height of the dams, a storage capacity curve of the reservoir or reservoirs showing the maximum, average, and minimum operating pool levels, the initial and ultimate installed capacity of the project, the rated horsepower and head on the turbines, and a curve of turbine discharge versus output at average and minimum operating heads.

(b)(1) A general map (one tracing and three prints) of any convenient size and scale, showing the stream or streams to be utilized and the approximate location and the general plan of the project.

(2) Also a detailed map of the proposed project area showing all Federal lands, and lands owned by States, if any, occupied by the project.

(3) A profile of the river within the vicinity of the project showing the location of the proposed project and any existing improvements in the river.

(4) A duration curve and hydrograph for the natural and proposed regulated flows at the dam site. Furnish references to the published stream flow records used and submit copies of any unpublished records used in preparation of these curves.

(c) (1) A definite statement of the proposed method of utilizing storage or pondage seasonally, weekly and daily, during periods of low and normal flows after the plant is in operation and the system load has grown to the extent that the capacity of the plant is required to meet the load. For example, furnish:

(i) Hydrographs covering a 10-day low water period showing the natural flow of the stream and the effect thereon caused by operations of the proposed power plant:

(ii) Similar hydrographs covering a 10-day period during which the discharge of the stream approximates average recorded yearly flow, and

(iii) Similar hydrographs covering a low water year using average monthly flows.

(2) A system load curve, both daily and monthly, and the position on the load curve that the proposed project would have occupied had it been in operation.

(3) A proposed annual rule of operation for the storage reservoir or reservoirs.

[Order 175, 19 FR 5217, Aug. 18, 1954, as amended by Order 260, 28 FR 315, Jan. 11, 1963; Order 540, 57 FR 21738, May 22, 1992]

PART 25—APPLICATION FOR VACATION OF WITHDRAWAL AND FOR DETERMINATION PERMITTING RESTORATION TO ENTRY

Sec.

§ 25.1 Contents of application.

Any application for vacation of a reservation effected by the filing of an application for preliminary permit or license, or for a determination under the provisions of section 24 of the Act permitting restoration for location, entry, or selection under the public lands laws, or such lands reserved or classified as power sites shall, unless the subject lands are National Forest Lands, be filed with the Bureau of Land Management, Department of the Interior, at the Bureau's office in Washington, DC or at the appropriate regional or field office of the Bureau. If the lands included in such application are National Forest Lands, the application shall be filed with the U.S. Forest Service, Department of Agriculture at the Forest Service's office in Washington, DC, or at the appropriate regional office of the U.S. Forest Service. Such application shall contain the following data: (a) Full name of applicant; (b) post-office address; (c) description of land by legal subdivisions, including section, township, range, meridian, county, State, and river basin (both main and tributary) in which the land is located; (d) public land act under which entry is intended to be made if land is restored to entry; (e) the use to which it is proposed to put the land, and a statement as to its suitability for the intended use.

(Secs. 24, 309, 41 Stat. 1075, as amended; 49 Stat. 858; 16 USC. 818, 825h)

[Order 175, 19 FR 5218, Aug. 18, 1954, as amended by Order 346, 32 FR 7495, May 20, 1967]

CROSS REFERENCE: For entries subject to section 24 of the Federal Power Act, see also 43 CFR subpart 2320.

§ 25.2 Hearings.

A hearing upon such an application may be ordered by the Commission in its discretion and shall be in accordance with the provisions of subpart E of part 385 of this chapter.

NOTE 1: On April 17, 1922, the Commission made the following general determination:

(a) That where lands of the United States have heretofore been, or hereafter may be, reserved or classified as power sites, such reservation or classification being made solely because such lands are either occupied by power transmission lines or their occupancy and use for such purposes has been applied for or authorized under appropriate laws of the United States, and such lands have otherwise no value

Industries

Hydropower - Regulation

Hydropower Regulation

- » Origin of Hydroelectric Regulation
- » Use and Regulation of a Renewable Resource
- » Hydropower Program
- » Dam Safety Program
- » Public Safety Program
- » Present Development of Conventional Hydroelectric Projects
- » Pumped Storage Hydroelectric Projects

Dam Safety Program

The Commission has the largest dam safety program in the United States. The Commission cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security.

Approximately 3,036 dams are in the program. Two-thirds of these dams are more than 50 years old. As dams age, concern over their safety and integrity grows, and oversight and a regular inspection program are extremely important.

The Commission staff inspects projects on an unscheduled basis to investigate:

- potential dam safety problems;
- complaints about constructing and operating a project;
- safety concerns related to natural disasters; and
- issues concerning compliance with the terms and conditions of a license.

Every 5 years an independent consulting engineer, approved by the Commission, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet (2.5 million cubic meters).

Many FERC-regulated project dams are located in seismically active areas like California and the Pacific Northwest. Due to concern that seismic events will adversely affect dams, the Commission retains the services of consultants for help at specific dams. Also, the Commission staff monitors and evaluates seismic research in geographic areas where there are concerns about possible seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects in these potentially affected areas.

The Commission staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, the Commission staff visits project dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The Commission publishes "Engineering Guidelines for the Evaluation of Hydropower Projects". This guides the Commission's engineering staff and licensees in evaluating dam safety. Additional chapters are being prepared and existing chapters are frequently revised to reflect current information and methodologies.

The Commission requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans are designed to serve as an early warning system if there is a potential for, or a sudden release of water from, a dam failure or accident to the dam. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows and procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that in emergency situations everyone knows what to do - thus saving lives and minimizing property damage.

Updated: February 10, 2006

APPENDIX G
MDNR/MDEQ Study Guide

stantec.com

Memo

Stantec

To:	File – Ann Arbor Hydro Feasibility	From:	Dana M Dougherty
File:	2075109900	Date:	June 4, 2008

Reference: Ann Arbor Hydro Feasibility – telecom with Jeff Braunscheidel, MDNR Fisheries:

ARGO

1. The fishery is currently not that good,however the downstream river habitat is good
2. Run-of river operation is impacted by the dam. Gate operation causes surges in the flow.
3. The MDNR is a proponent of dam removal.

GEDDES

1. The MDNR recently completed a fisheries survey of the impoundment.
2. The fishery is surprisingly good. It is a warm water fishery with large mouth bass, catfish, and walleye being recorded at significant numbers.
3. Most fish were found in the deeper waters near the lower end of the impoundment, however fish were found throughout the impoundment at all depths.
4. The oxygen level was good throughout the water column.
5. The MDNR would prefer to see a lower intake ie. bottom drawoff. Fish mortality concerns would need to be addressed.
6. The need for fish passage is not envisioned.

Stantec Consulting Michigan, Inc

Dougherty, Dana

From: Chris Freiburger [freiburg@michigan.gov]
Sent: Monday, April 28, 2008 11:58 AM
To: Dougherty, Dana
Cc: Jeffrey Braunscheidel; Gary Towns
Subject: Study Guidance for FERC Licensing and 401 Certification

Attachments: 2003 MDNR FERC Study Guidance.doc; 2003 MDEQ FERC Guidance for 401 Certs.doc

2003 MDNR FERC Study Guidance.... 2003 MDEQ FERC Guidance for 40...

Dana:

Attached are the guidance documents which will give a good indication of what we are looking for. If the City decides to move forward they would be tailored specifically for those projects but will remain fairly similar. If you have any further questions don't hesitate to give me a shout. thanks

Chris Freiburger
FERC Program, Supervisor
Fisheries Division
Michigan Department of Natural Resources 517/373-6644; phone 517/373-0381; fax
freiburg@michigan.gov

Guidance for Review of Water Quality Monitoring Plans at Hydropower Dams for 401 Certification

Introduction

This document contains guidance that staff will use for assessing adequacy of monitoring data that are collected to demonstrate compliance with water quality standards at hydropower sites. This guidance is meant to describe an approach which would, when executed properly, provide sufficient data for the Michigan Department of Environmental Quality (DEQ) staff to make a determination of compliance with water quality standards. The DEQ staff will use discretion and flexibility in the interpretation of this guidance keeping in mind site specific considerations as much as possible. Profile sampling, DO and Temperature sampling and chemical monitoring should all be done during the same year since they are meant to complement each other.

Chemical Analysis of Water and Sediment

The chemical monitoring requirements applicable to water samples collected from the impoundment are presented in Table 1. Water samples should be collected quarterly for a period of two years. At least one sample should be collected during summer stratification. The second year may be waived if the first year was performed satisfactorily and was representative with respect to weather and stream flow.

The chemical monitoring requirements applicable to sediment samples collected from the impoundment are presented in Table 2. Sediment samples should be collected once during the study period. Composite samples of fine grained, surface sediments should be collected from at least three points along a representative transect through the impoundment. The composite sediment samples should be collected in a manner consistent with GLEAS Procedure #64.

Fish Contaminant Analysis

Ten resident predator fish of legal size and of the same species should be collected from within the impoundment. The fish samples should be processed for analysis according to GLEAS Procedure 31. Existing data from a similar impoundment on the same river can be substituted.

The chemical analyses of fish should always include mercury. The following additional parameters could be necessary if contamination is expected: dieldrin, DDE, DDD, DDT, total chlordane, total PCB (Arochlors 1242, 1248, 1254, 1260), and toxaphene. This monitoring is not for remediation of problems and we will not hold dam owners or operators responsible for contamination that they did not cause.

It must be recognized that even the best of collection efforts may not result in exactly the numbers, size, and species of fish desired. Fish collection personnel should be encouraged to talk to the Fish Contaminant Specialist in the Surface Water Quality Division (Bob Day 517-335-3314) as the collections occur to clarify any questions about how to proceed if initial collection efforts are not completely successful.

Dissolved Oxygen and Temperature Monitoring

Two years of dissolved oxygen (DO) and temperature data should be collected between mid May and mid October at stations upstream of the effects of the impoundment and immediately downstream of the impoundment. The second year may be waived if the first year was performed satisfactorily and was representative with respect to weather and stream flow. The samples should be collected within one foot of the water surface.

Continuous monitoring is the best way to produce this long-term database. Grab sampling may be acceptable if a minimum of five days weekly are sampled with samples collected twice daily (near early morning low and afternoon high).

Validation of Continuous DO data

Continuous DO data should be validated at the end of each unattended monitoring period with an independent measuring system or by reading DO saturated water. This validation step is crucial and should be performed **before** any service or calibration procedures are performed on the recording instrument. The DO recording equipment should be serviced and re-calibrated (after the validation step is complete) approximately weekly but more frequently if the meter error is unacceptable with a weekly servicing schedule. The DO meter error or drift at the end of an unattended monitoring period should be less than 1 mg/l 70 percent of the time. More frequent service visits should be scheduled if this criterion is not met.

A second but less desirable method of validation is to compare the first reading of a freshly calibrated and deployed recording DO meter with the last reading of the previous deployment. This method is appropriate only if these two measurements are made within a short time of each other and only if it can be assumed and demonstrated that the D.O. does not typically change significantly in the time interval elapsed between the two measurements.

Analysis of Continuous Data

The data analysis should include but not necessarily be limited to the following:

1. A determination of the daily minimum, daily maximum and daily average DO and temperature for each day successfully monitored, and calculation of the average temperature for each calendar month.

2. An upstream/downstream comparison of the DO and temperature including the frequency and magnitude of any standard violations.

3. An evaluation of the correlation between any observed temperature or DO violations and other environmental factors that were monitored such as time of day, stream flow, sunlight, temperature, chlorophyll level, in-stream chemistry, and especially operating characteristics of the dam.

4. An accounting should be made for the entire monitoring period. Data gaps should be fully explained. Data of unacceptable quality such as time periods when a meter was out of water should not be reported. However, there must be a clear and objectively applied criterion for rejecting any recorded values.

Profile Sampling

Temperature and DO profiles should be conducted in the deepest part of the impoundment every two weeks from June 1 through August 31 and once mid-month for the months of February, April, May, September, and October during the same years that DO and temperature monitoring is done in the River. If dangerous ice prevents sampling safely during a given month then sampling can be conducted at the next safe opportunity. Measurements should be made at 0.5 meter increments or less. Secchi depth measurements should also be made at the same time as the profiling.

Quality Assurance

All measurements of water quality shall use methods approved by the EPA pursuant to 40 CFR §136 (1995). Detailed quality assurance/quality control procedures should be followed for all sampling, field analysis and lab analysis activities. For continuous DO data an objective evaluation of the validity of recorded values is essential. Simply stating that the meter started out calibrated does not validate data collected after the meter has been recording unattended for a week.

Prepared by: John Suppnick
Surface Water Quality Division
Michigan Department of Environmental Quality
April 8, 1999

Table 1. Quarterly Water Monitoring Requirements

Parameter
Alkalinity
Chlorophyll a
Total Arsenic
pH (S.U.)
Hardness
Secchi Depth (m)
Specific conductivity (umhos)
Total Ammonia
Total Dissolved Solids
Total Cadmium
Total Copper
Total Organic Carbon
Total Phosphorus
Total Suspended Solids
Total Lead
Total Nickel
Total Silver

Table 2. Sediment Analysis Parameters and Detection Limits

Parameter	Detection Limit (mg/kg)
Total Arsenic	0.5
Total Cadmium	2.0
Total Chromium	2.0
Total Copper	2.0
Total Lead	5.0
Total Mercury	0.1
Total Silver	0.25
Total Zinc	5.0
Total PCB	1.0

Michigan Department of Natural Resources
Recommended Review Criteria
And Study Guidance
For the Federal Energy Regulatory Commission
Licensing Process
2003

MICHIGAN DEPARTMENT OF NATURAL RESOURCES RECOMMENDED
REVIEW CRITERIA AND STUDY GUIDANCE
FOR THE FEDERAL ENERGY REGULATORY COMMISSION LICENSING PROCESS
February 4, 2003

Table of Contents

MICHIGAN DEPARTMENT OF NATURAL RESOURCES RECOMMENDED
REVIEW CRITERIA AND STUDY GUIDANCE
FOR THE FEDERAL ENERGY REGULATORY COMMISSION LICENSING PROCESS
February 4, 2003

The following are Michigan Department of Natural Resources (MDNR) review criteria, data needs and study guidelines for the Federal Energy Regulatory Commission (FERC) licensing process. These guidelines are intended to facilitate the FERC licensing and re-licensing process by informing licensees of MDNR positions and by detailing studies that will fulfill and facilitate this process. These criteria and study guidelines are not binding on the applicant and are intended to be used in conjunction with applicable FERC licensing statutes, rules, and regulations. These criteria and guidelines were developed in 1986, and revised in 1988, 1989, 1990, 1991, 1992, 1994, 1996, 1998, 2001, and 2003. This document will be reviewed and resubmitted to FERC on an annual basis.

MDNR Positions

1) Plant Operation

A) Daily Operation

i) Facilities with Riverine Tailwaters - We will recommend to FERC that the project(s) be operated as a run-of-river project (instantaneous inflow equals instantaneous outflow). The project will be limited to pond levels fluctuating $\leq$ 3" over the entire year.

ii) Facilities with Reservoir Tailwaters - We may recommend that FERC allow some minimal peaking operations with site-specific minimum flow and ramping rate requirements.

B) Operational Verification

We will recommend that data to verify the operation of the plant be provided and funded by the licensee. This will be accomplished using continuous gage stations on the reservoir to determine instantaneous headwater elevation, and continuous gage stations below the reservoir to determine instantaneous tailwater elevation. To provide independent data on project operation, we will recommend that the licensee fund the installation and maintenance of the appropriate number of United States Geological Survey (USGS) gages in the vicinity of the project. We may also recommend to FERC additional site-specific needs on a case by case basis.

2) Habitat

A) Comparative Aquatic Habitat Studies

We will recommend to FERC that all facilities with riverine tailwaters that choose not to operate their facilities as run-of-river operations conduct the following studies:

- Instream Flow Incremental Methodology (IFIM) studies on downstream river reaches for a comparative analysis of aquatic habitat under the proposed project operation(s) to run-of-river project operation
- Habitat Evaluation Procedures (HEP) studies on the reservoir to compare reservoir habitat under the proposed project operation(s) to run-of-river project operation

These studies are to assure that the appropriate amount of data is collected for an analysis of all operating scenarios. However, we will recommend run-of-river operation at all facilities to FERC in our final comments.

3) Fisheries

A) Fish Passage

We will recommend to FERC that appropriately designed, constructed, and operated fish passage facilities (for anadromous or other migratory fish species) be provided at all FERC projects. The recommendations for fish passage will consist either of fish passage facility construction and operation by the FERC licensee or dam removal. These recommendations will include time frames that may range from immediate to future implementation, depending upon the management goals for the river system. We will recommend that all passage and protective devices be evaluated for their effectiveness. MDNR may recommend that an escrow account be established to provide funds for the fish passage facility design and construction.

The purpose of fish passage is to: 1) regain access to spawning areas; 2) allow for the establishment of self-sustaining fish stocks; and 3) establish "special" fisheries of either state-wide or regional importance. In addition to upstream passage, downstream protection will be required at all projects.

B) Turbine and Spillway Entrainment and Mortality

We will recommend to FERC that the project be operated in a manner such that the entrainment and subsequent turbine and spillway mortality of fish will be minimized. To meet this request, the licensee can either immediately install protective devices to prevent entrainment and mortality or may decide to determine the extent of the problem via studies. The results of all studies and protective devices will be evaluated to determine minimum mitigation measures and effectiveness.

4) Woody Debris Transport and Management

We will recommend to FERC that the licensee develop a plan to improve aquatic habitat by maintaining and increasing the amount of large woody debris and vegetative material at the project. This woody debris plan shall be consistent with FERC boating safety requirements and any fish/watershed management plans.

5) Wildlife

We will recommend to FERC that all projects maintain and enhance wildlife resources found on their lands and develop plans to implement wildlife management.

6) Recreation

We will recommend to FERC that all project lands be open to public access. Project lands shall include boat launching facilities on the reservoir, fishing access sites and related facilities on the tailwater area, a safe marked canoe portage around the dam, and other facilities which MDNR views as necessary to optimize recreation on the project. All facilities should conform to the Americans with Disabilities Act (ADA).

All new recreation facilities should be constructed and maintained by the licensee. If public recreation facilities exist on the project, MDNR will recommend to FERC that the licensee provide maintenance funds or actual maintenance for those sites. If only private or leased facilities exist, MDNR will recommend to FERC that the licensee purchase the land and associated facilities. If this cannot be accomplished, MDNR will recommend that the licensee either purchase easements of lands or provide for free access to the project. The licensee always has the option to purchase and operate outright any recreational facility that it intends to use to satisfy FERC requirements. All recreational facilities used to meet FERC licensing requirements should be free of charge for public use.

7) Water Quality

Prior to development of a 401 water quality certification, we will recommend to FERC that flows for the facility, in addition to minimum flow, be maintained to alleviate any water quality problems that may be identified as having an adverse effect on restoring and maintaining productive aquatic resources.

The conditions that are established in the Section 401 certificate should govern the project operation in respect to water quality.

8) Coastal Zone

Federal Consistency is the Coastal Zone Management Act requirement that federal actions that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources, or coastal effects) must be consistent with the enforceable policies of a coastal state's federally approved Coastal Management Program.

Typically the Coastal Zone buffer extends not less than 1000' landward from the ordinary high water mark of the Great Lakes, but in many cases it extends significantly further inland (including coastal lakes and large river systems). The coastal zone does include the water areas around the coast such as rivers and lakes.

9) Mitigation Plan

We recommend to FERC that the licensee develop a mitigation plan to alleviate any adverse impacts and compensate for the loss of riverine habitat caused by plant operation. This plan should include a continuous program of analyzing and monitoring all planning, construction, and operational activities with respect to adverse impacts on the river ecosystem. We will also recommend that the licensee implement all measures necessary to correct any harmful effects identified during this ongoing monitoring program as a result of constructing, rehabilitating, operating, and maintaining the project.

Overview of Project Information and Impact Data Needs

1) Plant Operation and Engineering
   - A) Present plant design of all facilities
   - B) Daily operation and maintenance records
   - D) Plant hydraulic characteristics

2) Fisheries (Aquatic) Habitat
   - A) Hydrographic maps of the reservoir and the tailwater areas, to include 500 meters downstream of the project
   - B) An aquatic habitat inventory, may include IFIM and HEP studies if required by the proposed project
   - C) A determination of the impact of plant operation on habitat availability and quality

3) Fisheries Data
   - A) Fisheries community inventory of the riverine and pond areas, to include endangered, threatened, and sensitive species
   - B) The adequacy of the any existing fish passage facility
   - C) The impact of plant operations on the existing fish passage structure
   - D) If the project proposes to study the facility entrainment/mortality problem, a two-stage study plan should be used to examine the extent of the problem: 1) A reconnaissance study to determine the gross extent of facility entrainment and mortality, which should include turbines and spillways; and 2) If necessary, a more intensive study to keenly determine facility entrainment and mortality of fish. Our guidelines for these studies are attached in Appendix 4.
   - E) Aquatic habitat management plans

4) Wildlife (Terrestrial) Habitat
   - A) Terrestrial and wetland habitat inventory
   - B) Determination of the impact of plant operation on habitat availability and quality
   - C) Forest management plans of the project area
   - D) Topographical maps which show all project lands

5) Wildlife
   - A) Wildlife community inventory of the riverine and pond areas, including endangered, threatened, and sensitive species
   - B) Wildlife management plans in the project area, as determined by MDNR personnel

6) Recreation
   A) Inventory of recreational facilities in the project area, including written descriptions, maps, and diagrams of locations. This information will be used by MDNR to evaluate adequacy of facilities.

7) Water Quality
   A) All NPDES permits, Act 307, and Super Fund sites in the drainage basin should be identified
   B) All water management models and plans should be detailed
   C) The impact of the proposed project operation on water quality should be determined

8) Coastal Zone
   A) Federal and State Consistency must be determined under the Coastal Zone Management Act.
   B) Lands which fall within the Coastal Zone buffer should be identified.

Project Operation and Engineering Information

Project Design Information

1) The present plant design for all facilities should include the following details:
   - A) Plant engineering designs
   - B) Type, number, kW, blade number, RPM, and design of turbines
   - C) Elevation, peripheral velocity, and diameter of the runners
   - D) Minimum and maximum blade clearance between runner and wicket gates for Francis Type Units, and runner and the ring for Kaplan Type Units
   - E) Cavitation at the plant
   - F) Project map which includes all lands, roads (including condition), and right of ways
   - G) An updated turbine output-water use and spillway/gate rating curves for all project components

Daily Operation and Maintenance Records

1) The present daily operation of facilities should include :
   - A) kW
   - B) Wicket gate openings
   - C) Efficiency
   - D) Hours of use of each unit
   - E) Bypass gate openings for the previous and current year, as well as low, average, and high water years
   - F) Use mean, minimum, and maximum daily data for kW, wicket gate openings, efficiency, each unit's hours of use, and openings of bypass gates. This information should be used to calculate weekly mean values as well as mean weekly minimum and maximum values.

2) A record for the last 5 years of plant outages and length of outages

3) Any plans for plant operation automation, construction, major maintenance, or plant retirement

4) An estimation of the longevity of the existing facilities including powerhouse(s), penstock(s), reservoir(s) capacity, dam(s)

5) All dam safety reports should be summarized and made available to MDNR.

Project Hydrology Information

1) The daily fluctuation in the tailwater, any by-passed side channels, and reservoir should be reported for the previous year as well as average, high, and low water years. This should be reported in terms of discharge and elevation using mean, minimum, and maximum daily data to calculate weekly mean values, and mean weekly minimum and maximum values.

2) Monthly flow duration curves should be estimated for the river "without" plant operation and "with" plant operation for the assessment of minimum flow needs.

3) The operational compliance plan for all project operating conditions needs to thorough and should include continuous (at least hourly basis) monitoring water level gages in the reservoirs, headwater, and tailwater areas. Specifications for all gaging equipment should be completely described and submitted along with the provisions to provide for both the establishment and maintenance of a new continuous monitoring USGS gage or the maintenance of one existing continuous monitoring USGS gaging at each operating facility of the project. Plans should also include procedures for calibration and maintenance of gages. All other site-specific needs as determined by MDNR should also be documented in the compliance plan.

Fisheries (Aquatic) Habitat Information

Study Area

1. To include all reservoirs and stream reaches (including tributaries) from one-quarter mile above the high water level of the uppermost reservoir on the system to the downstream site of no project influence, as defined as follows:

   A. Mainstem of the River- From a point one-quarter of a mile upstream of the normal high water mark of the impoundment and downstream to the normal high water mark of the dam on the river. If the project has acceptable data that indicates that project influence zone is less than the recommended zone, the zone may be adjusted to reflect these changes in influence zone boundary after consultation and concurrence from the MDNR.

Hydrographic Maps

1. Hydrographic maps of the reservoir, any de-watered river reach, and the tailwater areas (to include 500 meters downstream of the facility) are required of all sites with transects every 10 meters. If recent existing maps are available, data verification studies can be substituted for mapping with MDNR concurrence. Additional FERC study justification is in Appendix 1.

   Maps should delineate the following habitat inventory data:

   A. Reservoirs - Predominant substrate (as classified using the Modified Wentworth Scale) and emergent and submergent plant beds (classified by dominant plant species complex) should be mapped on the hydrographic maps at all water levels. Other structure items such as logs, log complexes, and rock piles should also be denoted on the reservoir map.

   B. Tailwater areas - Predominant substrate (as classified using the Modified Wentworth Scale) and emergent and submergent plant beds (classified by dominant plant species complex) should be mapped on the hydrographic maps at all water levels. Other structure items such as logs, log complexes, and rock piles should also be denoted on the tailwater map.

   C. Other Project Impacted River Reaches - Predominant substrate, aquatic vegetation, and approximate mean depths should be indicated on river maps for all water levels.

Aquatic Habitat Inventory

1. Comparative Riverine Habitat Studies - Comparative riverine habitat studies will be recommended at all sites with riverine tailwaters that will not be operated as run-of-river facilities and that have no by-passed river reaches. The objective of this study is to compare resource impacts of the proposed project operation(s) to run-of-river operations. IFIM studies will be recommended at all sites unless another methodology is accepted by the MDNR. Additional study justification is in Appendix 2.

   The following guidelines should be followed in development of an IFIM study plan:

   A) The IFIM study plan will require close agency coordination on the following items:

      i. Study Purpose

      ii. Study Boundaries - The IFIM study boundaries should include all riverine tailwaters to the next lake or impoundment. In addition, we recommend that a pre-study be conducted determine the extent of downstream water fluctuations from each hydroelectric facility operations. This will be used to delineate modeling boundaries on the river.

      iii. Time Constraints –on dates for critical decisions and field studies.

      iv. Specific Study Objectives - Concurrence with MDNR needs to occur on the type of study and expected results. We suggest the following as an objective statement:

      The objective of this study is to determine the optimal flow regime from the hydroelectric facility to protect and enhance the aquatic resources of the river system. The IFIM study should provide recommendations that, at a minimum, protect the instantaneous needs of the aquatic community and provide data on the habitat usability of the river system(s) under a number of alternative operational schemes, including the proposed peaking operation and the strict run-of-river (instantaneous inflow equals instantaneous outflow) modes.

      v. Target Species - We need to discuss the target species desired and come to an agreement on those species.

      vi. Methodology - After agreeing upon the target species, we need to determine what habitat suitability criteria are available, which curves will be used, if any modifications are needed, and what data is needed. Decisions will also need to be made jointly on which models will be used in the study. We recommend that the attached two-flow analysis guidelines be followed to examine peaking impacts (Appendix 3).

vii. Hydrologic Baseline - After compilation of all available data on the river system, we need to jointly discuss and determine the "base" hydrologic conditions for present conditions.

viii. Stream Segmentation and Study Area Selection - We need to scope the river system and determine the logical study boundaries for each segment from a macro and microhabitat perspective. We need to determine and agree where microhabitat and macrohabitat measures are to be taken.

B) We recommend that the IFIM scoping document be organized in the following manner:

i. Introduction - To include:
- Purpose of the study
- Study objectives
- Existing management objectives for each section of river
- Important background data
- Existing flow agreements

ii. Study Plan - To include:
- general approach
- Study area and reaches with detailed maps and reasoning

iii. Study Tasks - To include:
- Study area reconnaissance and macrohabitat segmentation
- Habitat characterization and reach selections
- Hydraulic data acquisition (includes transect selection and placement procedures with maps, candidate transect location, measurement methods and materials which include target measurement discharges, anticipated logistics and field activities schedule, acquisition and handling of field data)
- Hydraulic modeling approach (includes microhabitat simulations, evaluation species/life species and suitability criteria, models used and two flow analysis technique)
- Data analysis and reporting (includes model output composites and report preparation)

iv. Study Schedule

v. Study Plan Agreement

2. Comparative Reservoir Level Fluctuation Studies - Comparative Reservoir level fluctuation and habitat studies will be recommended at all sites that are not to be operated as run-of-river facilities. The study objective is to compare resource impacts of the proposed project operation(s) to run-of-river operations. Habitat Evaluation Procedures (HEP) methodology, to predict changes in fish community structure based on habitat changes, will be recommended at all sites unless another methodology is accepted by the MDNR. Additional justification is attached as Appendix 2.

3. By-passed River Channel Minimum Flow Studies - On all projects that have by-passed river channels, we recommend that minimum flow studies be conducted on all by-passed river channels. IFIM studies will be recommended at all sites unless another methodology is accepted by the MDNR. Additional justification is attached as Appendix 2.

4. All aquatic habitat management plans should be identified

Fisheries

Aquatic Species Inventory

1. For all aquatic species, subdivide the systems by reservoirs and streams. Identify the relative abundance and species composition of each system using all available data sources which should include MDNR Fisheries, Michigan Department of Environmental Quality (MDEQ) Surface Water Quality Division, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Scientific Publications, and Universities. If acceptable survey data is unavailable, the necessary surveys will be conducted according to MDNR standards.

Threatened, Endangered, and Sensitive Species

1. Species to include all Federal listed, proposed, candidate, endangered, or threatened species. The list should also include Federal species of management concern, State-listed endangered or threatened species, and State species of special concern

2. For all species, determine whether they are present and map their location if possible. If existing surveys are unavailable, new surveys should be conducted according to MDNR standards. Surveys should be limited to identifying those species likely to occur within the available habitat types.

Upstream Fish Passage Device Inventory and Guidelines

1. All currently installed fish passage devices, both upstream and downstream, should be documented with operational designs included.

2. The current use of all upstream and downstream fish passage facilities should be described and include the fish species and number using the facility for all years that data are available.

3. The current project impact on any upstream or downstream fish passage facility should be documented. Additional studies on the adequacy of the facility may be required on a site-specific basis.

4. Fish passage designs, which should include upstream and downstream passage as well as prevention of turbine entrainment, will be recommended at some facilities as elected by MDNR. All passage designs should be developed using the fish species of interest as determined by MDNR. We will recommend that all passage devices be evaluated for their effectiveness.

Downstream Fish Passage Guidelines

1. We will recommend to FERC that plant operation minimize entrainment and subsequent turbine and spillway mortality of fish. The project can either immediately install protective devices to prevent entrainment and mortality or decide to determine entrainment and mortality via studies. We will recommend that all passage and protective devices be evaluated for their effectiveness along with minimum mitigation for any fish losses.

2. We recommend that the any turbine entrainment and mortality study follow the attached MDNR guidelines (Appendix 4). Additional justification for this study is provided in Appendix 5.

Woody Debris Transport and Management

1. We will recommend to FERC that the woody debris plan include procedures for:

   A) Passing large woody debris and vegetative material collected near the project trashracks and log booms into each project's tailrace

   B) Leaving currently existing instream and impoundment large woody debris unless it directly interferes with safe project operation

   C) Installing instream or impoundment structures for fish habitat or addition of large woody debris to the river below the projects when opportunities arise.

Wildlife (Terrestrial) Habitat Information

Study Area

1. For terrestrial species and associated habitat, include all lands within the project boundaries and influence zone.

2. For wetland and aquatic species, include reservoirs and stream reaches from one-quarter mile above the high water level of the uppermost reservoir on the system to the downstream site of no project influence, as defined as follows:

   A. Mainstem of the River- From a point one-quarter of a mile upstream of the normal high water mark of the impoundment and downstream to the normal high water mark of the dam on the river. If the project has acceptable data that indicates that project influence zone is less than the recommended zone, the zone may be adjusted to reflect these changes in influence zone boundary after consultation and concurrence from the MDNR.

3. For fish-eating birds including, but not limited to bald eagles, ospreys, herons, and other colonial nesting birds, incorporate an area of one mile on either side of the stream reaches and reservoirs defined under item 2.A.

Terrestrial Habitat Inventory

1. Collect and map terrestrial habitat data using MDNR approved classification systems. Provide percentage and acreage of each habitat type in the application

2. Collect and map wetland habitat data using USFWS mapping system (Cowardin et al.). Provide percentage and acreage of each wetland type in the application

4. Identify all forest management plans and terrestrial management plans

Shoreline Management Plan

1. Create a detailed shoreline management plan for licensee-owned lands and easements abutting project waters (within 1000 feet of the high water elevation for lakes and within 300 feet of the high water elevation for streams) that are determined to be needed for project-related purposes, such as providing public access for recreation or protecting sensitive, unique, or scenic areas. The plan shall include, but need not be limited to:

(1) a description of those lands covered by the plan including a drawing or map showing their location relative to project facilities or project waters (those lands shall be included within the project boundary);

(2) for each parcel of shoreline covered by the plan, a description of how the land will be managed and used;

(3) a critical habitat inventory of the shoreline;

(4) development of strategies and methods to educate property owners and reservoir users about the beneficial values of shoreline vegetation and shallow water habitats;

(5) a discussion of how the plan addresses the following considerations: selection of lands that are largely undisturbed and free from any observable past alterations that may have impaired their ability to provide the necessary protection and enhancement of wildlife and plant species; selection of additional lands to provide additional buffering capacity against adjacent land disturbances in ecologically sensitive areas; and selection of lands that would protect existing upper-canopy trees and their suitability for raptor use;

(6) development standards which include a setback of 200 feet from ordinary high water mark for all structures except piers, boat hoists, and boathouses; shoreline vegetation removal in the 35 foot strip adjacent to the ordinary high water mark will be limited; no more than 30 feet in any 100 feet may be clear cut (clear cut zone is limited to 10 feet in width); only 30% of the vegetation between 35 and 75 feet of the ordinary high water mark may be removed; and require that land uses be screened as viewed from the water and that the scenic beauty of the shoreline be maintained

(7) an implementation schedule.

The licensee shall prepare the plan after consultation with the Michigan Department of Natural Resources (MDNR), the U.S. Fish and Wildlife Service (USFWS), and the Wisconsin Department of Natural Resources (WDNR) and U.S. Forest Service (USFS) where applicable.

Wildlife

Wildlife Species Inventory

1. For wetland and aquatic species, subdivide the reservoirs and stream reaches into segments. Identify the relative abundance (common, uncommon, absent) of species in each area. Species should include water birds (seasonal designations will be needed for migratory use), marsh birds and the following mammals: otter, mink, muskrat and beaver. In particular, efforts should be made to determine the number of furbearers, water birds, and marsh birds breeding in the project influence zone and the nest or den locations. All existing data bases maintained by MDNR, WDNR (where applicable), USFWS, EPA, Michigan Breeding Bird Atlas, and universities should be examined and data compiled for this section. If no surveys exist, then field surveys should be conducted according to MDNR standards.

2. The following information may be recommended to evaluate timber management or other changes proposed to terrestrial habitat depending upon the project characteristics:

   a) The relative abundance of the following management indicator species: black throated green warbler, chestnut-sided warbler, eastern bluebird, pileated woodpecker, ruffed grouse, and white-tailed deer

   b) The relative abundance of owls and raptors not previously identified as threatened or sensitive

Threatened, Endangered and Sensitive Species

1. Species to include all Federal listed, proposed, candidate, endangered, or threatened species. The list should also include Federal species of management concern, State-listed endangered or threatened species, and State species of special concern

2. For all species, determine whether they are present and map their location if possible. If existing surveys are unavailable, new surveys should be conducted during the reproductive season (e.g., nesting, flowering) appropriate to each species. Surveys should be limited to identifying those species likely to occur within the available habitat types.

Bald Eagle Information

1. Map both active and inactive nest sites

2. Identify available habitat (described as relatively undisturbed areas with super-canopy trees)

3. Identify potential habitat areas within project boundaries, this will include areas where timber management could be used to develop appropriate habitat

4. Conduct a winter survey to determine over-wintering use and roost sites

5. Conduct a nest watch program during breeding seasons on at least two active nest sites per river system in order to determine the following information:
   - Extent of human disturbance to nest (identified by distance to nest site)
   - Food base (species and relative abundance)
   - Foraging locations on the reservoir or river systems
   - Roost sites, especially those used for foraging

6. For all other nest sites, including inactive nests, determine the extent of human disturbance by analyzing distances to roads, trails, rights of way, and other human activities

Recreation Information

Study Area

1. To include all reservoirs and stream reaches (including tributaries) from one-quarter mile above the high water level of the uppermost reservoir on the system to the downstream site of no project influence, as defined as follows:

   A. Mainstem of the River- From a point one-quarter of a mile upstream of the normal high water mark of the impoundment and downstream to the normal high water mark of the dam on the river. If the project has acceptable data that indicates that project influence zone is less than the recommended zone, the zone may be adjusted to reflect these changes in influence zone boundary after consultation and concurrence from the MDNR.

2. Project county areas for certain sections of the off-site inventory. This should include surrounding counties.

Data Needs

1) For the above project area, the following information is needed for each recreation site (developed and undeveloped):

   a) Map location

   b) Map key should indicate:
      1) Type of facility (see list below)
      2) Provider of facility (State, Company, Private)
      3) Size of facility (area, capacity)
      4) Level of use (heavy, light)
      5) Condition of site

   c) Summary table of facility type, condition, and provider

   d) Non-company facilities in the project boundary and their relationship (if any) to the company

   e) Commercial operators in the project boundary (e.g., liveries, bait shops, campgrounds serving the project area) and their name, location, size, etc.

2) A general description of relevant off-site recreation facilities within the county or counties where the project is located, along with a table of numerical totals of facilities and a description of major off site facilities.

This description is for the purpose of examining overall recreational use, availability of similar recreational opportunities, and recreational experience demand of the facility influence zone.

3) Identify any recreation plans that the licensee has written for the project.

4) Identify and summarize all existing data on recreational resources in the project influence area. Data sources include MDNR, Wisconsin Department of Natural Resources (WDNR) where applicable, U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (EPA), local governments, and universities.

5) A study will need to be conducted to determine the present and future use of all recreation facilities.

<u>Recreation Facility Type Categories</u>
Shore fishing site
Fishing dock or pier
Boat launch with ramp
Carry-in small boat access
Canoe portage
Beach for swimming or sunbathing
Trail (ORV, hiking, horse, fishing, other)
ORV/snowmobile area
Picnic sites
Campsites
Playgrounds
General use site (use for a variety of purposes)
Support facilities (rest rooms, fish cleaning stations etc.)
Other

APPENDIX 1. MDNR Justification for Mapping Studies

The following is the Michigan Department of Natural Resources (MDNR) justification for the recommended habitat mapping and hydrographic study at your facilities. This document fulfills the requirement of Subpart B, Section 16.8 (i)-(vi) of the recently adopted FERC rules governing resource agency recommendations for necessary studies and information relating to a recommendation for the comparative habitat study.

Data Recommended For Analysis of Issue by MDNR

1. Provide quantitative data that documents the extent of each habitat type in the tailwater and the reservoir. If the above information is not available, then the applicant should arrange to collect the information.

Determination Basis of Resource Issue

Hydropower operations impact our water resources by: 1) altering normal stream flows for generating purposes; 2) de-watering river channels by diversion or peaking operations; and 3) fluctuating reservoir levels for either peaking operations or for storage purposes. All of the above influences could be found at your project. The impacts of hydro operations that potentially could exist at your facility include the flushing of riverine reaches by generating with flood flows during the peak power periods and de-watering of riverine reaches at other periods. The de-watering of riverine habitat reduces the algae and aquatic plant life which are important as food for aquatic insects and which provide important fish nursery areas. Further, it reduces fish growth and survival by reducing available habitat and stranding fish, and changes the benthic invertebrate community to smaller, less useful, fish foods. The fluctuations cause downstream erosion and sedimentation that destroys fish habitat and can disrupt fish migratory patterns. In addition, hydro operations cause reservoir fluctuations that de-water and disrupt fisheries habitat, which could be up to 3 foot on a daily basis, in the same fashion as the tailwater habitats.

MDNR needs quantitative habitat data to examine the severity and extent of habitat loss under any proposed operational mode. Without a baseline map of depth contours and habitat types in the impoundments and tailwaters, it is impossible for our agency to determine the impacts of the present or proposed operational modes. These maps will provide the background data for recommendations on operations at the projects that will adequately protect this river system.

Fisheries Goals and Objectives

MDNR's overall aquatic habitat protection goal is:

> To minimize and mitigate the negative impacts of hydroelectric facilities by operating these projects in a fashion that offers aquatic resources and users near natural riverine and reservoir conditions, protects and maintains aquatic environments and fish communities and rehabilitates those now degraded.

1) Riverine tailwater facilities to be operated in a run-of-river mode

2) Reservoir tailwater facilities to be operated with minimal tailwater and headwater fluctuation

3) Bypassed and/or diverted river facilities to be operated in a manner which maintains healthy aquatic resources of the river

Michigan's river systems provide a significant fishery and public trust resource. The fisheries resource includes important populations of game fish which include largemouth bass, smallmouth bass, northern pike, walleye, bluegills, yellow perch, black crappie, rock bass, channel catfish, suckers (including redhorse) and bullheads. The habitat availability for aquatic species is limited by the operational mode of project.

Our specific fisheries habitat goal at your facility is to protect and enhance the fish communities in the river and tributaries by maximizing and stabilizing available aquatic habitat. In our agency's professional opinion, this is best accomplished by recommending run-of-river-operating conditions. Run-of-river is defined as instantaneous inflow to the project impoundment equals instantaneous outflow downstream of the project tailwater.

Study Methodology Appropriateness

The recommended study methodologies for predominant habitat type inventory and hydrographic maps of the impoundment and tailwater are essential. This baseline data will allow MDNR the opportunity to examine the impacts of water development and to recommend further study plans if necessary. This standard baseline information will also produce documentation of habitat types and depth contours that are needed to analyze the impacts of hydro projects.

Study Data Utilization

This study will provide initial data on the potential availability of fish habitat under a range of operating modes. This information will serve as qualifying data for our recommendations regarding IFIM and HEP study designs, if necessary. Ultimately, this data will allow for the determination of the operational mode under which the project will best protect the aquatic environment.

Our goals for protection and enhancement of the fish community call for the prevention of resource damage from hydroelectric generation and the optimal long term maintenance of the riverine fish community by maximizing and stabilizing the amount of available aquatic habitat. These data would provide the necessary background data to make the appropriate project operation recommendations to protect aquatic habitat in this river system.

APPENDIX 2. MDNR Justification for Comparative Habitat Studies

For those projects that propose peaking operation, the following is the Michigan Department of Natural Resources (MDNR) justification for the recommended comparative habitat studies using Instream Flow Incremental Methodology (IFIM) and Habitat Evaluation Procedures (HEP). This explanation fulfills the requirement of Subpart B, Section 16.8 (i)-(vi) of the recently adopted FERC rules governing resource agency recommendations for necessary studies and information relating to a recommendation for the comparative habitat study.

Data Recommended For Analysis of Issue by MDNR

1. Provide quantitative data that documents habitat availability in the tailwater and the reservoir under the proposed operational mode, run-of-river, and other operational modes. If the above information is not available, then the applicant should arrange to collect the information.

Determination Basis of Resource Issue

At a minimum, hydropower operations impact our water resources by: 1) altering normal stream flows for generating purposes; 2) de-watering river channels by diversion or peaking operations; and 3) fluctuating reservoir levels for either peaking operations or for storage purposes. The impacts of peaking and semi-peaking operations include the flushing of riverine reaches by generating with flood flows during the peak power periods and de-watering of riverine reaches at other periods. The de-watering of riverine habitat reduces the algae and aquatic plant life that are important as food for aquatic insects and provide important fish nursery areas. Further, it reduces fish growth and survival by reducing available habitat, stranding fish, and changing the benthic invertebrate community to smaller, less useful, fish foods. The fluctuations cause downstream erosion and sedimentation that destroy fish habitat and can disrupt fish migratory patterns. In addition, peaking operations cause reservoir and tailwater fluctuations (up to 3 foot per day), resulting in de-watered and disrupted fisheries habitat.

The resource agencies have requested that all hydro projects operate in a run-of-river mode, defined as instantaneous inflow equals instantaneous outflow, with essentially no pond elevation fluctuation. If you decide to operate your project in a peaking mode, the MDNR will need quantitative habitat data to examine the severity and extent of habitat loss under the proposed operational mode of semi-peaking. Both IFIM and HEP allow for meaningful comparisons of operational strategies and will provide the background data for recommendations on the project operation that will adequately protect this river system.

Fisheries Goals and Objectives

The Michigan Department of Natural Resources' overall aquatic habitat protection goal is:

> To minimize and mitigate the negative impacts of hydroelectric facilities by operating these projects in a fashion that offers aquatic resources and users near natural riverine and reservoir conditions, protects and maintains aquatic environments and fish communities and rehabilitates those now degraded.

1) Riverine tailwater facilities to be operated in a run-of-river mode

2) Reservoir tailwater facilities to be operated with minimal tailwater and headwater fluctuation

3) Bypassed and/or diverted river facilities to be operated in a manner which maintains healthy aquatic resources of the river

Michigan's river systems provide a significant fishery and public trust resource. The fisheries resource includes important populations of game fish which include largemouth bass, smallmouth bass, northern pike, walleye, bluegills, yellow perch, black crappie, rock bass, channel catfish, suckers (including redhorse) and bullheads. The present habitat availability would be limited by any proposed peaking operational mode at the project.

Our specific fisheries habitat goal at your facility is to protect and enhance the fish community in the river and its tributaries by maximizing and stabilizing available aquatic habitat. This is best accomplished by recommending run-of-river-operating conditions. Run-of-river is defined as instantaneous inflow to the project impoundment equals instantaneous outflow downstream of the project tailwater

Study Methodology Appropriateness

The recommended study methodologies IFIM and HEP are commonly used techniques to examine the impacts of water development. Both methodologies will produce documentation on habitat availability under a range of operational strategies that are needed to analyze the impacts of these facilities.

Study Data Utilization

This study will provide data on the potential availability of fish habitat under a range of operating modes that will provide for meaningful comparisons of the options available to the resource agencies and the city. These data will provide the basis for our recommendations on which operation of the project will best protect the aquatic environment.

Our goals of protection and enhancement of the fish community would be furthered by the prevention of resource damage from hydroelectric generation and provide for the optimal long term maintenance of the riverine fish community by maximizing and stabilizing the amount of available aquatic habitat. This study would provide the necessary data to make the appropriate project operation recommendations to protect aquatic habitat in this river system.

APPENDIX 3. MDNR IFIM Two Flow Analysis Guidelines October 1990

Introduction

Peaking operations cause impacts at both the low and high flow events. Low flow events mainly limit habitat by reducing both stream depth (de-watering habitat and stranding organisms) and water velocity. High flow events mainly limit habitat by increasing velocities beyond that used by organisms. The use of optimal flows from HABTAT and/or HABTAV for benthos and fish habitat only addresses low flow impacts, thus two flow analyses are needed to examine operational impacts at low and high flows. The following guidelines are for two-flow peaking analysis as discussed in Milhous et al. (1989).

Recommended Analytical Methodology

The intent in this type of study is to: 1) determine the actual peaking impact when movements ranges are known or to bracket the peaking impact when the actual movement ranges for species in question is unknown; and 2) compare the peaking operation to run-of-river conditions. Run-of-river should be simulated using the average daily discharge at peaking operations. The bracketing should be done by documenting the most conservative and liberal estimate of peaking impacts from both life stage (the movement question) and study area perspectives (independence of study reach question).

Two approaches to handle movement concerns for individual life stages should be used and are dependent upon whether the life stage or species was classified as a mobile or non-mobile. Non-mobile life stages and species are benthos, spawning and fry. Juvenile and adult life stages are should be classified as mobile. Recreational activities should also be classified as mobile. These approaches follow the procedures in Milhous et al. (1989) and communications with Milhous and Bartholow (personal communication, 1990). These approaches are described below:

Non-mobile species and life stages Peaking impacts on non-mobile life stages should be determined using the HABEF program. This program uses output files from HABTAT or HABTAV and examines WUA for each cell at both the generation and base flow. The lowest WUA of the two flows is then assigned to the cell for the summation of WUA for the reach. This approach assumes that no migration or movement occurs between cells, a realistic assumption for the non-mobile life stages and species. Run-of-river WUA should be determined using HABTAT or HABTAV results for the particular flow of interest. WUA percentage loss estimates for both the reach and whole study area should be calculated by dividing the appropriate peaking WUA (as determined by HABEF) by the appropriate run-of-river WUA (as determined by HABTAT) at each possible peaking discharge and multiplying these figures by 100.

Mobile life stages The impacts on mobile life stages with unknown home ranges should be determined using a combination of HABEF output and a comparison of whole reach generation and base flow WUA from HABTAT or HABTAV. The impacts should bracketed by presenting the results of the two extremes of movement which are: 1) no migration between cells or reaches as modeled by HABEF; and 2) complete migration through the entire reach as modeled by comparing HABTAT or HABTAV WUA results for generation and base flow for each case and using the minimum value of the two to represent the peaking impact. The actual impact has to be somewhere within this impact window between these two scenarios as it is unlikely that juvenile and adult fish will not move at all in response to changes in stage and flow, and it is equally unlikely that fish will travel through an entire reach multiple times per day in response to the changes in stage and flow.

The individual reach WUA estimate of peaking impacts that allows total movement within the reach should be determined using the minimum of generation and base flow WUA from HABTAT or HABTAV for a given reach. The no migration within a reach case WUA should be determined using HABEF output for a given reach as described above for the non-mobile species and life stages. Individual reach run-of-river WUA and percent loss for a individual reach should be determined as described above for the non-mobile species and life stages.

When the actual home ranges are known and are not greater than the cross sectional distance of the transects, then HABTAM can be used as the best estimate of the peaking impact. Individual reach run-of-river WUA and percent loss for a individual reach should be determined as described above for the non-mobile species and life stages.

Literature Cited

Milhous, R.T., M.A. Updike, and D.M. Schnieder. 1989. Physical Habitat Simulation System Reference Manual - Version II. Instream Flow Information Paper No. 26. U.S. Fish and Wildlife Service Biological Report 89 (16). v.p.

APPENDIX 4. MDNR Fish Entrainment and Turbine Mortality Study Plan Guidelines

Introduction

The Michigan Department of Natural Resources (MDNR) has determined that a study to quantify the magnitude of potential turbine-induced injury or mortality on the fishery resources is needed. The overall study has been broken down into two main components: monitoring fish entrainment and mortality rates and controlled turbine mortality experiments. The fish entrainment and mortality rate study (Phase 1) should be conducted initially. Based on the results of Phase 1 studies, the need for a more formalized turbine mortality study (Phase 2) will be determined. A phased approach to addressing the turbine mortality issue will preclude a potential applicant from conducting a, perhaps, unnecessary turbine mortality study. The MDNR may accept a potential applicant's proposal to conduct Phase 1 and Phase 2 studies concurrently, however. The MDNR may recommend that components of the studies be redone if the studies are not conducted as agreed to or if the results are not representative.

The potential applicant may opt to implement fish protective measures at the outset of after Phase 1 studies. In this case, the potential applicant will be required to conduct studies to develop appropriate mitigation measures. In all cases, licensees will be required to monitor the effectiveness of fish protective or mitigation measures once they are implemented. These studies will need to be coordinated with the MDNR.

The guidelines presented below identify the critical elements that must be included in a detailed plan of study developed by the potential applicant. Specific details, such as design of sampling equipment, sampling schedules, etc., will require coordination with the MDNR. The final study plan must be approved by the MDNR before studies are begun.

This document contains exact technical specifications that should be used to design an entrainment study. These specifications should be used in obtaining bid and study designs from consultants. These specifications are minimum specifications subject to discussion only when site-specific conditions warrant.

Phase 1 - Assessment of Fish Entrainment and Preliminary Mortality Rates

All entrainment studies should be designed to meet the following specific data objectives:

1. Estimates of the total number of each fish species (greater than one and a half inches) passing through the project during the study;

2. Estimates of the size distribution of fish entrained;

3. Estimates of the vertical and horizontal distribution of fish passing through the intake in one meter increments (pertains to hydroacoustic studies only); and

4. Estimates of the daily and hourly fish passage numbers through each turbine.

When an applicant is requested to perform an entrainment study, the protocol should be as follows:

1. Agency study specifications (this document) are provided to the applicant. MDNR and applicants may hold initial meetings to clarify the design or address specific concerns. Applicants should use the agency specifications as basis for obtaining consultants bids or scopes of work.

2. Applicant or consultant perform proof-of-concept study (POC) to verify that the procedures, equipment, and analyses proposed by the consultant will, in fact, provide the information promised

3. MDNR and applicant meet to review POC study results and develop scope of work for the entrainment study

4. Applicant conducts the entrainment study according to an agency-approved scope of work

<u>Proof of Concept Study (POC)</u>

To verify that the proposed study design will provide the data required for evaluating entrainment, a "proof-of-concept" (POC) study is required. The purpose of the POC is to determine the appropriate methodology to use at the site to determine entrainment. If hydro acoustics are proposed, then the POC should be designed to determine whether entrainment can be accurately estimated using this methodology and include tracking of live test fish. Ground truth netting should be used in the POC study to show an initial relationship between hydro acoustic sampling and tailwater netting. If a netting only study is proposed, the POC should show that entrainment can be accurately estimated using this method.

The POC study should be conducted for at least a two-week period to verify the applicability of the methodology selected. This study must be completed and reviewed by MDNR prior to the initiation of the scope of work. Each POC study must specifically address all of the technical and design parameters that are listed below. The procedures used must be fully documented.

A test-netting program must be conducted over a two-week period. This should include the installation and monitoring of the nets described below, a net efficiency study, and a visual evaluation by a SCUBA diver to confirm that the net support system is adequate and that the tailrace area is free of any obstructions that could tear the net or effect net fishability. Measures should be taken to prevent downstream infiltration of fish in areas where the net seal is not sufficient. In particular, the bottom seal should be examined as this is the area where infiltration problems usually occur.

The tailwater net efficiency study should include the introduction of at least 150 marked fish of various sizes and species into the turbine(s). A recapture rate of at least 70% of these fish is necessary to show that the nets are fishing properly. MDNR representatives should be notified prior to this test so they may observe and evaluate the operation.

Actual Entrainment Study

The following specific technical and design parameters must be incorporated into all studies. If site-specific conditions warrant the modification of these parameters, full justification and details of alternative methods must be provided to the MDNR. The MDNR must approve any deviation from the original plan of study prior to the start of the study.

If a hydro acoustic assessment is proposed:

1. Transducers should be placed so that at least 50% of the intake openings in all turbine bays that are sampled. Each transducer should operate for a period of no less than thirty minutes every hour. Near and far field dead zones must be fully measured and accounted for in consideration of the 50% coverage and vertical distribution requirements. Monitoring must be conducted 24 hours a day for at least one full year.

2. Single beam transducers should be used because they are less sensitive to noise and provide wide coverage. However, one dual beam transducer

per site is needed to develop a target strength distribution and effective beam angle.

3. The pulse width used should be 0.5 milliseconds or less

4. A scientific echo sounder with a frequency of at least 400 kHz should be used

5. An accurate 40 log R Time Varied Gain (TVG) must be used to account for range-related signal loss

6. The echo signal processor-sampling rate must be no less than 15,000 samples per second

7. The pulse repetition rate must be 10-15 pulses per second to ensure that targets will be fully tracked

8. All transducers and equipment will be properly calibrated. The actual equipment used in the study must be calibrated using standard Naval Lab hydrophones before and after the study. If the study lasts more than one year, this calibration should be conducted annually. In situ calibration should be conducted at the start and end of the study as well as every three months during the study. This calibration consists of cable and transducer impedance measurements, TVG shape, and standard target return. All calibration measurements must be maintained and reported with the study results.

9. Studies must use the echo-counting analysis technique unless the proportion of multiple targets exceeds 5%. Echo integration techniques are not recommended and are rarely necessary.

10. All data extrapolations and calculations must use the effective beam width as measured at calibration based on the target strengths appropriate for the species and sizes of fish expected to be seen at that site. Calculations based on manufacturers nominal beam widths are not acceptable.

11. Instrument specifications must be provided to the MDNR and copies of all equipment manuals must be available upon request.

12. Target-tracking/recognition processing can be used to differentiate fish from noise and debris. All tracking parameters, including filters must be agreed on up front in the scope of the work. In situ field measurements of representative fish targets should be conducted as part of the POC study.

13. A direct fish-counting fish flux estimation procedure is recommended because it directly incorporates target tracking. However, a mean density analysis procedure may be used if acceptable target recognition adjustments can be incorporated. In situ field trials may be needed to determine the efficacy of the two methods.

14. Target strength distributions and length relationships used to develop length distributions and effective beam width calculations must be fully documented. In situ lab measurements of batches of representative species and size fish should be conducted as part of the POC study. Correct all-aspect equations should be used where appropriate.

15. Site-specific noise levels must be adequately measured and mapped for each turbine bay. This should be conducted as part of the POC study. These should be incorporated into transducer placement plans and detection level estimates. The minimum effective detection threshold should be a signal return corresponding to a fish 1.5" in length.

16. All data extrapolation procedures must be fully documented prior to study initiation and use statistically valid procedures.

17. All hydro acoustics sampling must be accompanied by an appropriate level of tailwater netting (see below) to determine size ranges and species composition of fish seen in the hydro acoustics.

18. Hydro acoustics entrainment estimates must be correlated to net catch. Discrepancies suggest a design or configuration deficiency and should be addressed prior to study start. Calculations must be done at a minimum on a monthly basis with analysis of hourly counts on the time step, so those problems can be detected and corrected. These calculations should be included in the bimonthly reports.

Criteria for netting:

1. If a netting only study is proposed, at least 72 hours of netting at each unit should be done each week during the ice-free period (April-October). During winter months (November-March), 72 hours of sampling should be conducted on a biweekly basis assuming safe sampling conditions exist. If netting is done to ground truth hydroacoustics, a minimum of 24 hours should be done each week, April-October, and 24 hours biweekly, November-March. Sampling effort should be stratified on a weekly basis to make sure there is adequate coverage of all time periods.

2. The recovery net(s) should be constructed of dark colored (to minimize fish avoidance) 1/4 inch bar mesh, knotless nylon, with a removable live box attached to the cod end of the net. A fyke net should be incorporated into the net, near the live box, to prevent escapement. The effects of the recovery net(s) and live box on the mortality or injury of fish must be determined through suitably designed experiments. Divers should inspect all nets to ensure nets are fishing according to specifications. Nets should be appropriately marked immediately following inspection so that proper placement can be gauged each time the net is installed.

3. The recovery net(s) should sample the entire turbine discharge. A marked fish study should be conducted to determine the capture efficiency of the recovery net(s) and to obtain preliminary turbine mortality estimates. The capture efficiency of the net(s) must be quantified by releasing known lot sizes of marked live and dead fish at the intake. At least two capture efficiency/turbine mortality bouts should be done in addition to the bout conducted during the POC study. Species should be determined in consultation with the MDNR. The capture efficiency of the recovery net(s) must be based on the release and subsequent recovery of marked live and dead fish. Preliminary estimates of turbine mortality will be based on the release of marked live fish; live fish used in the preliminary turbine mortality study may be used concurrently as part of the study to quantify capture efficiency of the recovery net(s). The two size classes of each species, juvenile and adult, as defined in consultation with the MDNR, should be used. Three groups of fish of each species and size group are needed for these studies: 1) a control group of 10 fish per species and size class to examine handling and marking mortality, 2) a net control group of 10 fish per species and size class to examine net mortality, and 3) a test group of 50 fish per species and size class to examine turbine passage and net efficiency. Fish may be of hatchery, wild, or commercial catch origin.

   Suitably designed assemblies to introduce live and dead fish at the turbine intake must be used. Fish must be released at an appropriate location within the intake chamber to ensure entrainment of all released fish.

   All fish used in the marked fish studies should be held for a minimum of 48 hours to determine latent mortality.

4. If more than one operational turbine unit exists, selection of the units to be sampled should be done through consultation with the MDNR, but with the overall goal of estimating entrainment to ± 10%.

5. Installed nets should be flushed before the tests begin to remove as many "resident" fish as possible from the draft tube/tailwater area.

6. The species, size, and condition (live, dead, or injured) of all captured fish should be recorded. A randomly selected 10 percent of all fish used in the marked fish studies should be examined for internal injuries. Voucher samples of each species captured should be preserved so that MDNR can verify species identifications.

For all studies:

1. Environmental variables - data that should be recorded during the collection of each sample include a total river discharge (in cubic feet per second), percent gate opening (load level) and discharge (in cfs) of each sampled unit and of other operational turbine units, water temperature, dissolved oxygen, and transparency (Secchi disk), and other variables as identified by the MDNR. Also a velocity vs. depth profile to include vertical and horizontal velocity profiles should be obtained from directly upstream of the trash racks during low, average, and high water discharges.

2. Data analysis - a description of all statistical tests proposed for data analyses, including assumptions and how such assumptions will be addressed, significance levels, confidence levels, etc. must be provided and approved by the MDNR prior to study initiation.

3. Reports

   A. Written progress reports should be provided to the MDNR on a bimonthly basis throughout the study period, and should include a description of any intentional or unintentional deviations from the approved study plan.

   B. Reports should contain the following data:

      1. Hydro acoustic data

         a. Amount of time sampled by day and explanations of any down time in sampling
         b. Total daily fish passage
         c. Daily fish passage by hour
         d. Fish passage by location in the water column and across the intake structure
         e. Fish passage by size

      2. Netting data

a. Amount of time sampled by day and explanation of any down time in sampling
b. All fish data should be broken down by species and should include numbers and size (length)
c. Data should be presented to on an hourly, daily, monthly and annual basis, and by net location.
d. All fish with external and internal turbine passage damage should be documented

3. Environmental and Plant Parameters

a. Daily mean and hourly river flow in cubic feet per second (cfs)
b. Daily mean and hourly river temperature (°F) and dissolved oxygen (mg/l)
c. Daily mean and hourly headwater level
d. An hourly description of plant operation (units operating, each unit's discharge, % gate opening and Kw)
e. A daily summary of weather

C. A final study report is to be submitted to the MDNR within three (3) months after completion of the study.

D. The MDNR will provide written comments within three (3) months after receipt of the final report and will include any recommendations for further study, i.e., Phase 2, or for the need of appropriate fish exclusion or mitigation measures.

Phase 2 Study- Assessment of Turbine Mortality and Injury to Fish

This study is designed to develop intensive data on actual turbine-induced injury and mortality, based on the release and recovery of known lot sizes of marked test and control fish. Phase 2 studies are needed to more accurately quantify the occurrence and extent of turbine-related impacts to entrained fish.

1. Fish species of concern - target species and sizes to be studied will be determined through further consultation with the MDNR.

2. Sampling equipment

   A. Suitably designed assemblies to introduce test and control fish at the turbine intake and discharge must be used. Test fish must be released at an appropriate location within the intake chamber to ensure entrainment of all released fish.

   B. Total recovery net(s), if used, are to be located in the tailrace(s) as described above.

   C. Ichthyoplankton sampling equipment details will be provided by the MDNR if ichthyoplankton studies are deemed necessary.

3. Sampling protocol

   A. Fish injury and mortality experiments should be appropriately frequency as determined through consultation with the MDNR. In addition, the experimental design should include provisions for adequate sample sizes and an adequate number of replicates. Experiments should be conducted over the full range of normal project operating conditions, e.g., peak and off-peak.

   B. Live test and control fish selected from the same lot of fish should be acclimated to the project water for at least 24 hours. A third group of fish not subjected to the test and control procedures, selected from the same lot of control fish, should be held separately in holding cages in the tailrace to permit an assessment of non-test impacts.

   C. The effects of the fish introduction assemblies, the recovery net(s), and fish marking techniques (e.g., fin clipping, dye immersion) on the injury and mortality of test and control fish must be determined.

   D. The condition of captured fish should be categorized according to the following criteria.

- Live with no visible external injury
- Live with obvious external injury
- Dead with no visible external injury
- Dead with obvious external injury

Live test and control fish (with and without apparent external injury) recovered from the recovery net(s) should be held 48 hours in suitably designed holding cages secured in the tailrace to determine latent mortality of fish. Fish should be segregated by species and size to minimize stress and predation.

E. The number, species, condition, and size of all fish released and recovered in each trial must be recorded.

4. Environmental variables - see above

5. Data analysis - see above

6. Reports - see above. The MDNR will provide written comments within three (3) months after receipt of the final report and will include any recommendations for the need for appropriate fish exclusion or mitigation measures.

APPENDIX 5. MDNR Turbine Entrainment and Mortality Study Justification

The following is the Michigan Department of Natural Resources (MDNR) justification for the recommended turbine entrainment and mortality study at your facility. This document fulfills the requirement of Subpart B, Section 16.8 (i)-(vi) of the recently adopted FERC rules governing resource agency recommendations for necessary studies and information relating to a recommendation for a standard turbine mortality/entrainment study.

Data Recommended For Analysis of Issue by MDNR

1. Provide quantitative estimates of the number, species composition and size distribution of fish being entrained at the project; or acceptable quantitative estimates of the above parameters from a comparable project; or acceptable quantitative evidence that installed protective devices are preventing fish entrainment.

2. Provide quantitative estimates of the mortality rate of fish being entrained at the project and the source of the mortality (turbine mortality, impingement on intake screens, etc.); or acceptable quantitative estimates of the above parameters from a comparable project; or acceptable quantitative evidence that installed protective devices are preventing fish mortalities.

   If the above information is not available, then the applicant should arrange to collect the information using recommended survey procedures provided by the MDNR.

Determination Basis of Resource Issue

Numerous studies have been conducted to determine the extent of fish entrainment at hydroelectric projects nationwide with many of them summarized in Eicher et al. 1987. Unfortunately, most of these studies have been conducted at West Coast facilities and deal with migrating salmonid smolts. A number of entrainment studies have also been done on the east coast, targeting on anadromous species such as shad, striped bass, alewife, blueback herring and Atlantic salmon. These studies have shown that mortalities can be significant and range between 5-90% per facility. Very few entrainment studies have been done in the Midwest, where the hydroelectric facilities and their design, fish community composition and fish sizes are very different from those examined in the literature. Thus, little is known concerning turbine entrainment and mortality in the Midwest.

In the past, many fisheries biologists felt that the fish species indicative of Midwestern rivers were fairly sedentary and did not move long distances. These "resident" fish have recently been found to move long distances putting themselves at risk from turbine mortality. Studies by WDNR personnel on walleye in the Mississippi River, smallmouth bass in the Embarrass River, and channel catfish in the lower Wisconsin River all have shown movement of each of these species in excess of 30 miles over one year. In addition, studies on the threatened lake sturgeon in the Menominee River by Tom Thuemler have shown yearly movements of at least 20 miles with some radio tagged fish moving through hydroelectric facilities.

Summaries of the few recent entrainment studies on Midwestern rivers have shown large amounts of movement through hydroelectric facilities. The Morrow Dam Study, using tailwater netting, on the Kalamazoo River in Michigan estimated 45,987 fish passing the facility consisting of 21 species, ranging in size form 1.8 to 32.4 inches, in 6.5 months of sampling. Hydro acoustic studies at the Park Mill facility on the Menominee River showed daily movements of from 216 to 10,017 fish and hydro acoustic/netting studies at the Vanceburg hydroelectric plant on the Ohio River estimated hourly movement at from 282 to 6,000 fish.

The magnitude of resident Midwestern fish movements, available Midwestern data on entrainment and the wide range of known fish mortalities have led us to determine that turbine entrainment and mortality occurs at our facilities. Legally, all fish are property of the State of Michigan, under Public Act 165 of 1929 and any fish killed by any non-legal means are to be compensated for. Therefore, we are requesting a turbine entrainment and mortality study be conducted at your facility to determine the nature and degree of mortality, and to determine the necessary mitigation for those losses.

<u>Fisheries Goals and Objectives</u>

The overall Michigan Department of Natural Resources' goal on hydroelectric facility entrainment and mortality is:

> To minimize and mitigate for the loss of fish at every hydroelectric facility from either turbine or spillway passage to protect and maintain fish communities, and rehabilitate those now degraded.

Michigan's river systems provide a significant fishery and public trust resource. The fisheries resource includes important populations of game fish which include largemouth bass, smallmouth bass, northern pike, walleye, bluegills, yellow perch, black crappie, rock bass, channel catfish, suckers (including redhorse) and bullheads. Our fisheries goal in respect to entrainment and mortality at your facilities is to protect and enhance the fish community in the river and its tributaries by minimizing and mitigating for fish losses from hydroelectric facility entrainment and mortality.

Study Methodology Appropriateness

In order to adequately determine turbine entrainment and mortality a direct sampling system is needed. The joint agency, MDNR, WDNR and the U.S. Fish and Wildlife Service, sampling guidelines use a two-phase approach. Phase I is designed to determine entrainment and to estimate the magnitude of mortality. If mortality is found to be a problem then more detailed mortality studies are recommended as part of Phase II. Our hope and intent is that most of the studies should stop at Phase I, instead of requiring both phases to be done at once.

This overall methodology is preferable and less costly than trying to determine whole system effects. Whole system effects would require detailed and long-term population dynamics of each member of the fish community. Turbine entrainment and mortality data would still need to be collected and compared to natural mortality and year class strengths. By using just direct sampling techniques, mitigation measures can be more easily determined, and the very large and costly sampling effort can be avoided. This overall methodology also follows the methodology the State of Michigan uses to determine mitigation for fish kills. For example, if farmer X kills fish in drain A, we require direct compensation for those fish killed not a river system wide impact statement as these fish are property of the State of Michigan killed in an illegal method. We view turbine mortality as a chronic fish kill situation.

This overall methodology has been used before in numerous turbine mortality studies including Morrow Pond, Park Mill and Vanceburg studies. The actual methodologies recommended, hydro acoustics and tailwater netting, are commonly used as can be seen in the review by Eicher et al. (1987).

Study Data Utilization

This study will provide data on the numbers entrained and the mortality of each member of the fish community of the river and its tributaries at your hydroelectric facility. These data will then be converted to a mitigation value by either a lost angler day determination or some other acceptable technique. These mitigation values will be used to determine if the problem is severe enough to require screening, which is always an alternative to the study, or some other mitigation to replace the lost resource value.

Our goals of protection and enhancement of the coolwater fish community would be furthered by the replacement of lost resource values from hydroelectric generation if the losses are not severe enough to warrant protective devices or the complete exclusion of fish, by protective devices, if the losses are significant.

Thus, no net loss of the fisheries resource value would occur in either case because of the results of this study.

Literature Cited

Eicher, G.J., M.C. Bell, C.J. Campbell, R.E. Craven and M.A. Wert. 1987. Turbine Related Fish Mortality: Review and Evaluation of Studies. Electric Power Research Institute Report No. AP-5480.

Dougherty, Dana

From: John Suppnick [suppnickj@michigan.gov]
Sent: Thursday, May 01, 2008 4:13 PM
To: Sharon Hanshue; Dougherty, Dana
Cc: freiburgc@michigan.gov; Byron Lane; Joseph Leonardi
Subject: Re: City of Ann Arbor - Hydroelectric Feasibility Study

Attachments: FERCGuidance.doc

FERCGuidance.doc
(43 KB)

Dana and Sharon,
What Sharon attached to her email is the Department of Natural Resource guidance for studies needed during licensing. I have attached the Department of Environmental Quality guidance. There is significant overlap in these two documents but they are different. Let me know if you have any questions.

John

John Suppnick
Michigan Department of Environmental Quality Water Bureau
517-335-4192
suppnicj@michigan.gov

>>> Sharon Hanshue 5/1/2008 3:50 PM >>>
Hi Dana - I don't recall if Chris has responded to your message already, but I will also give you my thoughts.

First - FERC would have some potential oversight for any power generation since it would be generating on a navigable river. They do have a regulatory class of "exempt" for the smallest generators. Your feasibility study should review the exempt standards. The "exempt"
doesn't mean the facility operates without any conditions however, and we would want to review the operation of the proposed facility to ensure that adverse impacts to fisheries, wildlife, recreational use of the river and the river itself are minimized as much as possible. The DNR and DEQ have a specific advisory role to FERC for such matters, as you may know.

As for DEQ requirements, obviously you'd need to talk with them. Some reconstruction of the dam and addition of power generating facilities will likely be subject to Part 301 permit (Inland Lakes and Streams).
There is also the potential that you would need to secure a 401 Water Quality certification. DEQ has written guidance on what's needed to be issued the 401 certification (attached). If the dam is not FERC regulated then it would also be subject to the Dam Safety requirements for emergency spillway capacity, among other things. I am attaching the
401 Cert guidance for your reference (even if a 401 is not required) since it outlines the positions we've advocated regarding operational mode, etc.

I don't know the condition of the Argo or Geddes dams, but the Hamilton dam is in poor condition, like most non-generating dams of this age group. They have all been discussed as potential candidates for removal to restore free flow of the river and eliminate the public safety liability and the long-term maintenance costs. I would encourage you to do a comprehensive feasibility study that examines the long-term economic viability of power generation that includes these less obvious costs including fish passage, recreational passage, long-term dam maintenance, and retirement of the dams at the end of their useful life.
An even more valuable study would be one that considers the costs and benefits of dam removal or modification as an option to power generation.

For a list of species of interest to pass at the Hamilton dam, contact Joe Leonardi (810-245-1520), I believe Chris would assist with fish passage design, but given our very substantial work load, we're unable to review fish passage design for any of these dams until it appears that power production is a viable option and acceptable to the communities.

Sharon Hanshue
Supervisor, Habitat Management Unit
MDNR - Fisheries Division
hanshus1@michigan.gov

"The more clearly we can focus our attention on the wonders and realities of the universe about us, the less taste we shall have for destruction."
Rachel Carson, 1954

>>> "Dougherty, Dana" <Dana.Dougherty@stantec.com> 04/24/2008 10:27:25 AM >>>

Sharon/Chris,
We are currently performing a preliminary feasibility study of redeveloping hydropower at the Argo and Geddes dams on the Huron River in the City of Ann Arbor. These are City owned facilities and as such they have commissioned the study. We would like to speak to you about the MDEQ's requirements pertaining to these facilities in order to incorporate such in our study. Please note that we are evaluating the possibility of using generated power internally "off grid" which may have an impact on FERC jurisdiction. If I am not available at the below listed number please feel free to contact me on my cell (734-368-3107).
Chris, I also left a telecon message relative to the Hamilton Dam on the Flint River within the City of Flint. We are also performing a feasibility study for the City on that facility and I would like to speak to someone from MDEQ/MDNR about fish passage and water quality issues related to the various options being studied including full or partial removal.
Thanks,
Dana M Dougherty, P.E.
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Guidance for Review of Water Quality Monitoring Plans at Hydropower Dams for FERC Relicensing and 401 Certification

Introduction

This document contains guidelines that staff will use for assessing adequacy of monitoring data that are collected to demonstrate compliance with numerical water quality standards at hydropower sites. This guidance is meant to describe an approach which would, when executed properly, provide sufficient data for Department of Environmental Quality (DEQ) staff to make a determination of compliance with numerical water quality standards. DEQ staff will use discretion and flexibility in the interpretation of this guidance keeping in mind site specific considerations as much as possible.

Chemical Analysis of Water and Sediment

The chemical monitoring requirements applicable to water samples collected from the tailrace are presented in Table 1. Water samples should be collected quarterly for a period of two years. At least one sample should be collected during summer stratification.

The chemical monitoring requirements applicable to sediment samples collected from the impoundment are presented in Table 2. Sediment samples should be collected once during the study period. Composite samples of fine grained, surface sediments should be collected from, at least, three points along a representative transect drawn across the width of the impoundment. The sampling points along the transect should be selected to represent shallow and deepwater conditions. The composite sediment samples should be collected according to GLEAS Procedure #64.

Fish Contaminant Analysis

Ten resident predator fish of legal size and of the same species should be collected from within the impoundment. The fish samples should be processed for analysis according to GLEAS Procedure 31. Existing data from a similar impoundment can be substituted.

The chemical analyses of whole fish samples should always include mercury. The following additional parameters could be necessary if contamination is expected: dieldrin, DDE, DDD, DDT, total chlordane, total PCB (Arochlors 1242, 1248, 1254, 1260), and toxaphene. Fish samples should be collected once during the study period. This monitoring is not for remediation of problems and we will not hold dam owners or operators responsible for contamination that they did not cause.

It must be recognized that even the best of collection efforts may not result in exactly the numbers, size, and species of fish desired. Fish collection personnel should be encouraged to talk to the Fish Contaminant Coordinator in the Surface Water Quality Division as the collections occur to clarify any questions about how to proceed if initial efforts are not completely successful.

Dissolved Oxygen and Temperature Monitoring

Two years of dissolved oxygen (DO) and temperature data should be collected between mid May and mid October at stations upstream of the effects of the impoundment and immediately downstream of the impoundment. The second year may be waived if the first year was performed satisfactorily and was representative with respect to weather and stream flow. The samples should be collected within 1 foot of the water surface.

Continuous monitoring is the best way to produce this long term database. Grab sampling may be acceptable if a minimum of 5 days weekly are sampled with samples collected twice daily (within two hours after sunrise and at or near 4 PM) until it is demonstrated that the difference between morning and afternoon samples is usually less than 2 mg/l. Once this demonstration has been made then only early morning samples are necessary.

Validation of Continuous DO data

Continuous DO data must be validated at the end of each unattended monitoring period with an independent measuring system or by reading DO saturated water. This validation step is crucial and should be performed **before** any service or calibration procedures are performed on the recording instrument. DO recording equipment should be serviced and re-calibrated (after the validation step is complete) approximately weekly but more frequently if the meter error is unacceptable with a weekly servicing schedule. The DO meter error or drift at the end of an unattended monitoring period should be less than 1 mg/l 70% of the time. More frequent service visits should be scheduled if this criterion is not met.

A second but less desirable method of validation is to compare the first reading of a freshly calibrated and deployed recording DO meter with the last reading of the previous deployment. This method is appropriate only if these two measurements are made within a short time of each other and only if it can be assumed and demonstrated that the surface water being measured does not typically change significantly in the time interval elapsed between the two measurements.

Analysis of Continuous Data

The data analysis should include but not necessarily be limited to the following:

1. A determination of the daily minimum, daily maximum and daily average DO and temperature for each day successfully monitored. And calculation of the average temperature for each calendar month.

2. An upstream/downstream comparison of the DO and temperature including the frequency and magnitude of any standard violations.

3. An evaluation of the correlation between any observed temperature or DO violations and other environmental factors that were monitored such as time of day, stream flow, sunlight, temperature, chlorophyll level, in-stream chemistry and especially operating characteristics of the dam.

4. Data must not be censored. An accounting must be made for the entire monitoring period. Data gaps should be fully explained.

5. For continuous DO data an objective evaluation of the validity of recorded values is essential. Simply stating that the meter started out calibrated does not validate data collected after the meter has been recording unattended a week later.

Profile Sampling

Profile sampling, DO and Temperature sampling and chemical monitoring should all be done during the same year since they are meant to complement each other.

Temperature and DO profiles should be conducted in the deepest part of the impoundment every two weeks from June 1 through August 31 and once mid-month for the months of February, April, May, September and October. If dangerous ice prevents sampling safely during a given month then sampling can be conducted at the next safe opportunity. Measurements should be made at 0.5 meter increments or less. Secchi depth measurements should also be made at the same time as the profiling.

Quality Assurance

EPA approved methods must be used for all measurements. A detailed quality assurance/quality control section should be included in all study plans that addresses all sampling and analysis.

Prepared by: John Suppnick
Surface Water Quality Division
Michigan Department of Environmental Quality
April 2, 1999

Edited 7-19-06 by John Suppnick

Table 1. Quarterly Water Monitoring Requirements

Parameter	Frequency
Alkalinity	Quarterly every fifth year
Chlorophyll a	Quarterly every fifth year
Total Arsenic	Quarterly every fifth year
pH (S.U.)	Quarterly every fifth year
Hardness	Quarterly every fifth year
Secchi Depth (m)	Quarterly every fifth year
Specific conductivity (umhos)	Quarterly every fifth year
Total Ammonia	Quarterly every fifth year
Total Dissolved Solids	Quarterly every fifth year
Total Cadmium	Quarterly every fifth year
Total Copper	Quarterly every fifth year
Total Organic Carbon	Quarterly every fifth year
Total Phosphorus	Quarterly every fifth year
Total Suspended Solids	Quarterly every fifth year
Total Lead	Quarterly every fifth year
Total Nickel	Quarterly every fifth year
Total Silver	Quarterly every fifth year

Table 2. Sediment Analysis Parameters and Detection Limits

Parameter	Detection Limit (mg/kg)
Total Arsenic	0.5
Total Cadmium	2.0
Total Chromium	2.0
Total Copper	2.0
Total Lead	5.0
Total Mercury	0.1
Total Silver	0.25
Total Zinc	5.0
Total PCB	1.0