§ 5.6 (d)(3) – Description of Existing Environment and Resource Impacts

§5.6 (d)(3)(i) General Requirements:

As a rule, background information in this PAD is provided from three sources. The first set of information has been retrieved from project planning efforts in the 1970s and 1980's, and during the past twelve months. The Passamaquoddy Tribal Council at the Pleasant Point Reservation submitted a series of applications with FERC and the State of Maine during the 1980s which serves as the public record for this document and source of information.

As a rule, the prefix "HMC- XX" will be used to reference Tables, Figures, Exhibits, and Appendices in a sequential manner.

The second source of baseline data was retrieved from the State of Maine and FERC applications submitted by Quoddy Bay LNG with special emphasis on the information provided for the pipeline section which was proposed to traverse the middle section of Half-Moon Cove. Tidewalker Associates has installed the PAD on its web site at: http://mainetidalpower.com along with appropriate links to public documents. This information will be used to assist in the characterization of Half-Moon Cove on the basis of environmental parameters and resource utilization features from public facts pertinent to the project's review and evaluation.

The third source of information refers to public documents and scientific reports pertinent to the characterization of Half-Moon Cove from a literature and policy search as specified by FERC and as revealed during this investigation.

A description of any known or potential adverse impacts and issues associated with the construction, operation or maintenance of the proposed project including continuing and cumulative impacts appears in § 5.6 (d)(3)(i)(C) as presented in this section in accordance with the FERC guidelines which are reproduced in "text boxes" and in italics.

§ 5.6 (d)(3)(i)(A) – Summary of Existing Environment

(A) A description of the existing environment as required by paragraphs (d)(3)(ii)–(xiii) of this section;

Subsequent sections of the PAD will provide a descriptive summary of other subsections following § 5.6 (d)(3)(i) from (ii) to (xiii) in accordance with FERC nomenclature. The entrance to HMC was once spanned by a wooden toll bridge as depicted in Fig HMC-02. In the following pages, a summary of the existing environment has been extracted from a historical Half-Moon Cove description which still applies as listed below and bordered by heavy dashed lines (please disregard references to documents which are not preceded by HMC-XX):

(1) DESCRIPTION OF THE EXISTING ENVIRONMENT

A great deal of the information presented in this section was taken from a report prepared by the U.S. Fish and Wildlife Service and titled, "An ecological Characterization of Coastal Maine", October 1980. Atlas Maps 1-4 (Region 6 Map 7) are especially useful for characterization of Half-Moon Cove. Inventory lists of natural and wildlife resources appeared in the Chas. T. Main feasibility study prepared for the Passamaquoddy Tribal Council (November 1980).

A. Land Features and Uses

Half-Moon Cove, a small cove with a surface area of 1.27 square miles is located in the northern part of Cobscook Bay, Maine. The proposed barrier is located on the site of the "Old Toll Bridge" now dismantled, on the road connecting Eastport and Perry. Quoddy Village is located on the lower east shore and the Pleasant Point Reservation is located on the upper east shore. Medium paved highways are located surrounding the cove and Maine Central Railroad track beds run along the east shore into Eastport, Maine. The majority of the cove bottom is mud and/or gravel or boulders. Maximum water depth of the cove is 27 feet below mean low water (see Plate 3-1).

The surrounding region excluding the two settlements mentioned above, is sparsely settled. The surface area is hilly with a maximum elevation of approximately 145 feet above mean sea level. There are two minor fresh water streams entering the cove on the west side.

A.1 Land Uses

The factors mentioned below represent an initial assessment of the more obvious physical parameters. This discussion should be regarded as an overview of the more discernible and measurable aspects of the project.

a) basin size: the surface are of Half-Moon Cove is approximately 795 acres at mean high tide, and 290 acres at mean low tide; the dimensions and configuration of the tidal basin is depicted on Figure B.1 ,
b) tidal range: the best source of information on this topic is the International Joint Commission report entitled, "Investigation of the International Passamaquoddy Tidal Power Project", App. 3, October 1959; the results of that investigation which covered the period from 1930 to 1956 are summarized below:
   - observed tide ranges at Eastport averaged 18.1 ft. and vary from 11.3 ft. to 25.7 ft.
   - observed monthly mean tide ranges averaged about 0.3 ft. greater than predicted
   - annual mean tide ranges can be accurately predicted for many years ahead from the mean observed tide range
   - the average tide range for a 19 year period increased by 0.01 ft. per year
   - a complete tide cycle is represented by a 19 year period
   - minimum average annual tide range was observed in 1930 (17.2 ft.), maximum range of 18.54 ft. in 1940
   - the occurence of the most recent minimum and maximum tide range would correspond to 1987 and 1978, respectively.

d. transmission line: an electrical transmission line from the Bangor Hydroelectric Company passess overhead of the proposed dam site; presently the line can carry up to 6,000 kw of power, but an expected line improvement program scheduled for completion in 1983 will allow 12,000 kw of transmitted power,
e. abutting property: Half-Moon Cove is located between the communities of Eastport, Perry, and the Pleasant Point reservation; homes located near the tidal basin are residential units and number between 80-100 units,
f. boating: Half-Moon Cove is not highly navigated during any season; three boats at most are moored in the tidal basin on an atypical summer day; daily traffic is also quite low and never exceeds five separate occurrences in one week.

Information contained in the solid box was taken from Quoddy Bay LNG (2007) submittal for FERC permitting. In this case, it is being used to characterize the natural surrounding of the area around Half-Moon Cove as third party verification.

8.1.3.1.3 Half Moon Cove of Cobscook Bay

A segment of the LNG Transfer System will cross Half Moon Cove (also known as Frost Cove and Bar Harbor) within the greater Cobscook Bay. A small segment of approximately 700 feet will be located on submerged lands, which begin at low water on Split Rock, and extend westerly and then southwesterly across Half Moon Cove to low water on the western shore of Half Moon Cove.

Historically, Half Moon Cove was associated with the Western Passage as water could flow between Split Rock and Carlow Island, but with the development of the Passamaquoddy Tidal Power Project in the 1930s, a causeway was constructed between Pleasant Point, Spilt Rock, Carlow Island, and Quoddy in order to force water in and out of a narrow passage between Quoddy and the mainland. Therefore, all water entering and exiting Half Moon Cove now passes through Cobscook Bay which lies along the western boundary of the Western Passage, and extends westward into Washington County, Maine. Cobscook Bay opens into the Bay of Fundy through a narrow opening at Friar Roads which lies immediately south of Eastport and north of Lubec, Maine. Cobscook Bay is further artificially subdivided into three sub-regions: the Inner, Outer, and Central regions based on general shape and circulation patterns.

At high tide, Half Moon Cove consists of a sheltered bay and is used occasionally for recreation in small boats. At low tide, it consists of extensive tidal mud flats with a narrow shallow channel running down the center. The submerged lands in Half Moon Cove are used seasonally for scallop dragging. The mud flats are used seasonally for commercial and recreational clam and marine worm harvesting.

8.1.3.1.4 Contiguous Parcels off Old Eastport Road in the Town of Perry

The Storage Facility (and that portion of the LNG Transfer System and Sendout Pipeline between low water and the Storage Facility on the western shore of Half Moon Cove) will be located on several contiguous lots located in the Town of Perry, Maine. These parcels are identified on Perry Tax Map 4, as Lots 7, 8, and 9. Lot 7 is located to the west of Old Eastport Road, and Lots 7 and 8 are to the east of Old Eastport Road.

The topography of these parcels is flat to gently sloping, from a topographic high in the western portion of the site, to a topographic elevation approaching sea level to the east, where the property adjoins Half Moon Cove. Lots 7 and 8 are currently undeveloped, previously logged, and forested land. A single vehicle sand and gravel access road runs through Lots 7 and 8 in an approximate west-east direction. The western portion of Lot 9 is forested, while the eastern portion contains blueberry barrens. A gravel road diagonally bisects the northwestern corner of the parcel. A small family cemetery (Trott Cemetery) is located in the southwestern corner of Lot 9.

The neighborhood surrounding these parcels is primarily low-density residential and undeveloped forested properties. Current uses of the adjoining properties include: forested, undeveloped land to the West; residential properties to the North; residential property and Half Moon Cove to the East; and forested, undeveloped land followed by residential properties to the South. There are no prime farmland soils on any of the proposed LNG Terminal parcels.

In addition, contractor equipment staging areas and a temporary worker camp are proposed on nearby parcels in this area (Perry Tax Map 4, Lots 17 and 18).

The majority of Perry is undeveloped and in a natural state. Of the approximately 18,600 acres in Perry, only a few hundred acres are developed. Most of the developed land is in residential use. Between 80 and 90 percent of Perry is forested. Much of the remainder of the town is either open fields or abandoned fields that are reverting to woodland (Scanlon, 1993).

§ 5.6 (d)(3)(i)(B) – Summaries of Data and Studies

(B) Summaries (with references to sources of information or studies) of existing data or studies regarding the resource;

A list of the sources of information used for the PAD preparation is included in Appendix HMC-03. In Exhibit HMC-04, an overview of the project's impact appears for concerns raised in the 1980s. This evaluation was provided on the premise that the tidal range within Half-Moon Cove would be reduced by more than 50%; however, the present mode of operation is based on a 2-3 foot increase in the elevation of low tide. Under present conditions, environmental impacts have been reduced substantially without drastically affecting energy production or project costs.

§ 5.6 (d)(3)(i)(C) – Known or Potential Adverse Impacts & Issues

(C) A description of any known or potential adverse impacts and issues associated with the construction, operation or maintenance of the proposed project, including continuing and cumulative impacts; and

Known and unavoidable consequences of the construction, operation, and maintenance of the

proposed project are associated with the installation of a dam or barrage at the entrance to Half-Moon Cove

will be addressed in terms of the following features of project development: (1).construction; (2) operation; and (3),.decommissioning.

The material included here after the summary will give historical perspective on the original project from the 1980's bordered by dashed lines. A clarification will be provided when needed to indicate that the earlier study was based on a more extensive reduction of the tidal range within the impoundment; however, many of the conclusions still apply today along with most of the factors of interest in evaluating adverse impacts..

(1) Construction: Impact on Environment:

Due to the present state of project design, a decision has not been finalized on the composition of the dam at the entrance to Half-Moon Cove. The traditional design is based on a rockfill composition as illustrated in Figure HMC-03. This design would allow the placement of a secondary road into Eastport and / or rail traffic across the dam.

A, so-called, tidal wall is an option as previously described in an earlier section of the PAD. In this case, steel or composite material piers would be driven into the overburden of the site and panels would be placed horizontally between the piles to create a water tight barrier. A traditional concrete power plant would be placed between piers and secured in place with a similar pile driven configuration. The emptying filling gates would be placed within the same section of the dam used for the power house.

In comparison to a rockfill dam, the tidal wall would have a much smaller footprint and, therefore, represent less transition in surface area from an intertidal zone into permanently covered terrain. A tidal wall would reduce the time of construction and decrease the sedimentation load expected during the placement of a rockfill dam. From various studies conducted on the construction of a major dam (e.g., Department of Interior, circa 1963), a sufficient and local supply of rockfill dam material is available near the proposed site.

A final decision on dam design will depend on a number of factors which will include: (1) local desire for a second access road into Eastport; (2) employment opportunities with the installation of civil works element of barrage design; (3) environmental issues; and, (4) lifetime and maintenance expectations for the two options. Both methods are considered technically feasible and current estimates favor the tidal wall based on economic considerations. Regulatory mandates for decommissioning requirements would also favor a tidal wall unless multi-faceted considerations are placed in the decision process. For example, a request to remove traffic from the Pleasant Point Reservation might increase the appeal for a rockfill dam.

The possible placement of emptying / filling gates in the existing causeway between Pleasant Point Reservation and Carlow Island represents a similar uncertainty on design decisions. In this case, the capacity to control flow into Half-Moon Cove from

Passamaquoddy Bay offers both technical and environmental benefits which have been discussed in this PAD. These factors will be considered during on-going project phases.

C. Effect of Construction

The major construction activities associated with the Half-Moon Cove project include dredging including disposal, blasting, placing of rockfill, and placing of concrete structures. As a result of these activities, short term increases in turbidity and sedimentation rates and modifications in current patterns and scoured areas are predicted. The magnitude of these impacts will be determined by the method of dredging, type and chemical composition of spoil material and volume and method of spoil disposal. The Corps of Engineers have the responsibility to issue a dredging and excavation permit (sec. 404) which determines the adequacy of the method proposed for construction. The 404 permit application will be submitted after the FERC license application and will be prepared in accordance with guidelines established by the Corps of Engineers and in agreement with the general methods prescribed in this repor

The construction effects associated with the project are summarized as follows for the previously identified categories of concern:

1. Marine and terrestial geology
   - several terrestial sites will supply material (e.g.; gravel, armor stone) for the rockfill dam; each site when identified will have to be individually evaluated with respect to their suitability as a quarrying or mining site.
   - site preparation for the Perry side of the barrage would involve a different set of concerns than the Eastport segment due to the use of cofferdam construction versus "dumping in the wet"; the Perry barrage would be constructed in the dry and would follow a systematic method of overburden removal and material placement whic would therefore produce a negligible amount of sedimentation; the removed overburden would be placed in a suitable terrestial land-fill as designated in the 404 application.
   - on the other hand, the Eastport embankment would require material placement on the overburden with site preparation; the design attempts to minimize the velocity profile over the inter-tidal zone in order to reduce the sedimentation/erosion rate; however, this method of barrage construction will inevitably cause sedimentation which is mitigated by keeping the emptying/filling gates open; the environmental effect (i.e., sedimentation/erosion) is considered minimal and short-term; in this case, a suitable landfill site for the overburden would not be required.
   - the powerhouse would be similarly constructed in the dry behind the cofferdam; rock excavation would amount to 7,900 cu. yd. (powerhouse), 5,000 cu. yd. (gate structure), and 3,400 cu. yd. (staging areas); presumably the excavated rock can be used for part of the construction of the barrage.
   - the rockfill dam is comprised of a clay core which will be dredged from a suitable marine source; regulations set forth in guidelines for a section 404 permit will be followed when an application is

submitted.
- construction activity will not endanger a seismic reaction due to the site's geological characteristic (i.e., relatively free of earthquakes during recent times) and due to the project's size.
- erosion of the overburden along the Eastport embankment will be maximized when the cofferdam is completed since the basin's entrance (i.e., dam site) will be reduced by nearly two-thirds of its normal cross-sectional opening; the modified velocity profile will therefore increase the erosion/sedimentation rate

2. Hydrological
- the normal pattern of currents will be modified at the dam site according to the different phases of construction.
- as the cofferdam gradually approaches completion, the basin's entrance will be correspondingly reduced and thereby redirect the tidal flow across the intertidal zone and submerged area located between the cofferdam and the Eastport shoreline; this case represents the extreme condition of diversionary tidal flow from the normal channel flow and will last approximately 12-18 months.
- as the cofferdam is removed, the emptying/filling gates will be left open allowing part of the tidal exchange to follow its normal course; however, a greater percentage of the tidal flow will pass through the gates as the Eastport embankment approaches completion.
- when both embankments are completed the tidal exchange will be fully directed through the gates; the currents near the dam will be greatly intensified as a result of the diverted and constructed flow; however, the tidal range might be reduced only slightly during this period since the gates have been designed to handle the highest tides; i.e., spring tides.
- the currents within the impoundment and in Cobscook Bay will not be affected in magnitude or direction as a result of the project's construction since the tidal range will remain essentially unchanged or unaltered in both instances.
- wetlands and estuaries will be unaffected since the normal high and water levels remain unchanged.
- groundwater impacts from salt water intrusion is similarly non-existant.
- potential impacts from storm surges (e.g., slope erosion) will be beneficial to certain sections of the impoundment.

3. Physical oceanography
- changes to: (1) major physical properties; (2) flushing time; (3) bacteria count; and (4) ice regime will not occur during the construction phase since the tidal range will not be significantly reduced.
- notions that the harmonic behavior of the tides (i.e., tidal resonance) would be changed by the barrage's construction have been rejected on the basis of discussions with an individual involved in the mathematical modelling of the Bay of Fundy tidal projects and from an intuitive judgement of Half-Moon Cove's physical features (i.e., a regular configuration); also since Half-Moon Cove

comprises less than 2% of Cobscook Bay's surface area, the driving or harmonic force of the tidal function entering Cobscook Bay will be presumably unaffected by the barrage built in Half-Moon Cove.

4. Water and sediment chemistry
   - increased sedimentation caused by the erosion of the overburden and the placement of rockfill/gravel/clay will affect the water quality (i.e., turbidity), but this effect will be highly localized near the dam site and quickly dispersed in the tidal flow.
   - the problems related to the existing influx of untreated sewage from Quoddy Village will not be aggravated by the construction activities at the dam site due to the distance between the point source and the localized disturbance.

5. Climatology
   - needless to say the general climate will be unaffected by the construction works.

6. Ecology
   - the removal of overburden, the loss of an intertidal area at the dam site, and the dredging of marine clay represents a long-term loss of marine life and habitat at the designated sites; this area amounts to approximately 10-25 acres; as a result of these activities, short-term increases in turbidity and sedimentation rates and modifications in current patterns and scoured areas are predicted; the magnitude of these impacts will be determined by the method of dredging, type and chemical composition of spoil material, and volume and method of spoil disposal.
   - the physiochemical changes associated with these construction activities will affect the aquatic populations of Half-Moon Cove; phytoplankton productivity may temporarily decrease if light penetration is reduced as a result of turbidity.
   - high concentrations of suspended solids localized at the dam site may temporarily affect the population by reducing productivity and altering depth distribution of the zooplankton.
   - the benthos population will be affected by loss of habitat due to dam construction and dredging; if sufficient sedimentation and turbidity occur, changes in species abundance and composition are possible; if sedimentation occurs in nearby areas of the dam, clam beds will be adversely affected.
   - the finfish population will be unaffected in the construction area since turbidity and sedimentation changes are expected to be localized; similar fish habitats are located nearby throughout Cobscook Bay; anadromous fish populations are uncommon in Half-Moon Cove and, therefore, will not be affected; foraging activities of some groundfish species will be curtailed in and out of the Cove; indigenous populations of winter flounder will be unaffected since spawning is local and there is little or no dependancy on migrant individuals that enter the Cove.
   - marine mammals will be relatively unaffected since sightings were limited to only a few harbor seals.
   - some feeding areas of shorebirds and waterfowl will be permanently lost due to dam construction in the intertidal zone, but several

alternative feeding areas are located throughout the Cove and the Cobscook Bay area; the noise associated with construction activities will temporarily disturb the bird population present in the area.
- land clearing and excavation activities for the power plant related facilities will have a limited effect on the floral and faunal populations in this area; some permanent loss of habitat is expected, but overall, the extent of damage will be minimal due to man's prior encroachment of the area; a public road exists at the site of the proposed tidal power plant.

7. Land use
   - since the dam will be located on an intertidal and submerged area, the impacts to existing land use and water use refer principally to navigation and shellfish harvesting, respectively; these impacts are discussed elsewhere.
   - the dam will join to a public road which previously connected Eastport and Perry; this is a beneficial impact since a second route will be formed to connect the two communities; the roadway across the dam will increase the traffic on the existing deadend sections of the public road.
   - the existing transmission line abutting the site is inadequate; a new 34.5 kV line from Half-Moon Cove to Pembroke will be installed along the existing transmission corridor, a distance of 7.5 miles.
   - the main water line crossing the dam site will be relocated on the physical structure; a positive benefit is attached to this act since the main line needs repair.
   - the construction of the dam will be an obstruction to navigation; however, since Half-Moon Cove sees hardly any traffic the impacts are considered minimal; the Coast Guard and the Corps of Engineers will be contacted to determine the degree of navigational interference and to devise possible mitigation measures (e.g., boat landing).
   - the construction of the dam will not obviate and existing recreational use of the region.
   - the aesthetic impacts associated with the project will depend quite significantly on the perspective of the beholder; a person opposed to any form of development will denounce the project since it changes a natural setting; on the other hand, the project can also be judged in terms of its efficient utilization of a natural resource in an environmentally responsible manner; visually, the project will resemble one of the existing rockfill causeways except for the turbulent waters near the powerhouse; the turbines and gates will be located below the lowest low water level.

8. Social and economical
   - it is considered that the impact of the work force should be minimal on community services. It may be considered that a figure of 33% of the estimate of 110 man years or 37 may be local hires leaving 73 as imports. Many of the skills required may not be available locally and thus the number of 73 import labor. However, if requisite skills are found locally, the ratio will change accordingly thus further minimizing imports. It must be borne in mind that the 110 man years is not for one year but spread over the 2½ years of construction in possible peaks and valleys dependent on

weather conditions. Housing should be adequate especially if some imports use trailers. Hospital facilities are adequate, as too is water supply and schools. Feeding facilities could be stressed by family unaccompanied imports. There will probably be in the range of 25 to 30 maximum at any one time.

- due to the isolation of the area, the obtaining of construction materials will be hard to provide from local sources. Remembering that with the exception of the turbine/generator units and filling gates, all other material procurement will be the responsibility of the general contractor to whom the construction contract is awarded. Items definitely requiring non-local procurement are electrical controls, steel sheet piling, reinforcing steel, structural steel, and guard rails. As to concrete, it will be the option of the contractor to obtain the 26,430 cubic yards required from local concrete plants if available or to set up his own batch plant on site. Opportunities for local procurement are form lumber, nails, wire; rockfill and armor stone; sand and gravel for cell fill and embankment filters; small tools; and certain rental equipment. Of course, the latter procurement depends on competitive pricing.
- it is estimated that total salaries expended over the 2½ year construction period will be approximately $3,200,000 (before payroll deductions).
- some stress may be placed on police personnel due to construction workers but the degree, if any, is unpredictable.

(2) Operation: (A) Effect on Tidal Range

In the original design's scheme of operation for the power house in the 1980's, the reduction in tidal range approached 50% within Half-Moon Cove. Through the use of reversible turbines and the incorporation of a novel mode of operation, the tidal range reduction is now expected to range from 2-3 feet at the low tide mark within the impoundment. In ecological terms, the net impact of this modification should be viewed with respect to the normal fluctuation experienced in Half-Moon Cove now for an ecosystem functioning between neap tide and spring tide conditions which range from 12' to 26' in vertical measure, respectively, during a period of approximately two weeks. The term "spring tide" is a misnomer since spring tides occur roughly twice every month during a calendar year. During the fall and spring equinox, the "spring tides" are higher than the previous six month period due to the interrelationship between the moon, sun, and earth.

The lowest low tide levels are experienced during "spring tide" conditions. Conversely, the highest low tide levels are observed during neap tides. The difference in elevation for these two events is approximately seven feet with the same differential observed at the high tide level for the two extreme tides (i.e., neap and spring). Due to this mechanism, organisms and plant life within a tidal environment survive by adapting to a varying tidal range within the region between lowest and highest low tide and also in the area between lowest and highest high tide at the upper end of the water column.

In the region between the highest low tide and lowest high tide, intertidal areas will always experience the presence of a tidal function which floods and ebbs across the terrestrial surface.

In the region between the lowest high tide and highest high tide, tidal waters will not cover intertidal area for neap tides and will experience progressively longer periods of water cover when proceeding from neap tide to spring tide conditions.

Finally, in the region between the lowest low tide and highest low tide, a different mechanism is noted depending on the phase of the tidal cycle. For neap tide conditions, the area will always be covered by water; i.e. submerged. For other tides, this area will be uncovered for short (but progressively longer) periods of time when proceeding from neap to spring tide conditions.

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A tidal power plant is drastically different than a normal hydro-electric plant because it does not have to create a permanent storage volume to maintain (i.e., balance out) discharge during a calendar year. A tidal power plant also allows for two way transfer of water in nearly the same time pattern as a normal tidal cycle. Under our proposed mode of operation, a slight volume of water will be established conceptually as permanent storage from the lowest low tide mark to approximately 2-3 feet above this elevation which also equates into a slight reduction in the volume of water transfer across the opening of Half-Moon Cove during a tide cycle. A tidal dam retains water to create potential energy and later releases tidal waters to optimize the generation of kinetic energy for an installed capacity selected to consider volume fluctuations during the lunar tide cycle. The following information is provided on water volume within Half-Moon Cove under different conditions for natural tidal fluctuations and under an assumed mode of electrical generation which would raise the low tide level by 2-3 feet for any tide.

In essence, the ecosystem's ability to adapt to a varying tidal function is an indicator of the system's sensitivity to changes within that environment. In the case of the proposed changes associated with the operation of the Half-Moon Cove project, the permanent alteration to the tidal regime refers to the volume of water contained from the lowest low tide level (at spring tide) up to 2-3 feet above this elevation. After initiation of tidal power generation under this mode of operation, this volume element (i.e., permanent storage) will never experience an intertidal environment and represents an area of approximately 140 acres of presently unproductive habitat which will be transformed into permanently submerged lands. Under the present regime, this periodic intertidal environment which has the longest time duration for spring tides only occurs for short periods of time during a calendar year. For convenience, this area will be referred to as the "low spring tide zone" which is characterized as being either a very muddy surface without any vegetation or as exposed ledge extending into submerged land.

Our hypothesis is that the increase of 2-3 feet in the level of low tide from the operation of the tidal plant will not substantially affect the environmental quality within the impoundment since it is less than the approximate seven foot difference at the low end of the tidal spectrum experienced by the ecosystem during the normal progression from

neap tide to spring tide conditions. The lower end of the area between the lowest low tide and highest low tide is characterized as being commercially unproductive since it functions under a demanding schedule of intertidal and submerged conditions. The lower end of the "low spring tide zone" is primarily submerged and the upper end is primarily intertidal as determined by the sequence imposed during the progression from neap tide to spring tide conditions.

This mechanism also has an influence on other changes (e.g., water temperature) anticipated as a result of the modified tidal range in the impoundment. Intuitively, the changes will be less as one approaches the normal tidal function. An anticipated increase of water temperatures during the summer due to the modified tidal regime is expected to be less than the normal year to year variation observed under present conditions. The induced impact on salinity is another factor which is expected to fall within the present annual variations during the course of time.

In terms of continuing or cumulative impacts, the ecology of Half-Moon Cove will be exposed to a continuous pattern of water movement after the project has been placed in operation which is very similar to present variations in tidal elevation. The transition from natural to modified conditions will occur quickly and is not expected to adversely affect the environment of Half-Moon Cove due to the inherent ability of marine species and plants to adapt to changes as reflected by its present ability to adapt to a regular pattern of influence from neap to spring tide conditions and back down to neap tides. A difference of seven feet in vertical distance between low tide levels and high tide levels has created an environment capable of adapting to varying tidal conditions.

(2) Obstruction of Passage: (B) **Operational Impacts**

The barrage at the entrance to Half Moon cove at the site of the powerhouse will restrict passage of traditional fishing and recreation boats. Safety restriction areas will have to be created on either side of the installation to prohibit any boat traffic from coming too close to discharge points . The gates and turbines are designed to allow for safe passage of fish species and the Maine Department of Marine Resources has previously decided that fish passage was not required for the project based on a design which would have reduced the tidal range within Half-Moon Cove by more than 50% on the normal tidal range.

For boat traffic, several concepts are under consideration. One option involves the placement of boat ramps on both sides of the dam with provisions for boat hoists to enable access during Half-Moon Cove during slack tide conditions. Another option is to place a boat ramp further from the dam to allow the placement and retrieval of boats during high and mid-tide conditions. In any event, the impact on fishing and recreational use of Half-Moon Cove will be considered during the development phases of the project.

D. Effects of Operation

The alteration of the tidal regime will be the primary effect of the tidal project when in operation. The tidal range within the cove will be decreased and the tidal phase will be delayed. The historic mean high tide level will remain relatively unchanged. But a reduction of approximately 65% of the mean tidal range is expected at the lower end of the tidal spectrum.

In order to properly view the environmental implications associated with the tidal range reduction, the operation of the tidal plant will be discussed in more detail with respect to production parameters. An earlier section described the proposed mode of operation. Table I-1 listed the low tide elevations and the amount of tidal exchange expected during the operational phase for tides ranging from 12 ft. up to 24 ft.. An assumed trapezoidal configuration was used to calculate the basin's water capacity for an assumed 65% tidal range reduction within the impoundment.

Table II-2 presents additional information on the operation of the gates and turbines for tides ranging from 12 ft. up to 24 ft.. As an example, for a 12 ft. tide the filling gates would be open for 18.3% of the tide cycle and closed for the remainder of the time. However, tidal exchange would occur during 59.5% of the tide cycle; i.e., during production mode and filling process. Otherwise, the basin would remain at either a high level (i.e., head development) or at a low modified level (i.e., level stabilization) for 40.5% of the time during which tidal volume exchange would not occur. The symmetry of the tide's ebb and flow behavior would also be changed, since the basin's discharge would comprise 41.3% of the tide cycle as opposed to 18.3% of the time during the basin's filling. This fact translates into a filling rate which would be 2.25 greater than the discharge rate. However, the velocity profile at and near the discharge

and filling points will not be substantially different due to the greater cross-sectional area available during the basin's filling process; i.e., turbine bays and gate openings.

The operating characteristics noted in Table III-2 are extremely important factors when assessing the potential impacts attributed to a modified tidal regime caused by the project's operating schedule. For example, successful fish passage will be a direct function of the various species' abilities to adapt to a filling/emptying pattern which is modified in terms of attraction flow, flow duration, vertical placement of access/egress points, and hydraulic characteristics at and near the barrage. However, the primary effect of operation remains focused on the tidal range reduction in the impoundment and the resultant impact on the basin's ecological balance.

The method used to define and discuss the array of operational effects will be identical to the method used to assess the construction impacts. Table III will once again serve as the guideline for our presentation.

1. Marine and terrestial geology
   - once the plant is placed in operation, the terrestial geology will remain unchanged; the normal high tide level will not be exceeded and will, therefore, not pose any degradation problems to the existing shoreline; the higher mean basin level within the impoundment will have a negligible effect on the geological substructure as related to a possible increase in the amount of salt water intrusion.
   - the power plant will not progressively increase the probability of potential seismic impacts; this concern was addressed in subsection "c" (effects of construction) relative to the site's subsurface geological profile and to the historical data of seismic activity; public safety hazards due to the barrage's collapse have been similarly dismissed due to the fact that any flooding would not reach beyond the normal high tide level.
   - the marine overburden near the turbine's discharge area will experience increased erosion during the first few years of operation; sedimentation rates will therefore increase until suspended particle movement have attained a stabilized state; this localized and temporary effect will not significantly alter the marine environment.

2. Hydrological
   - significant modifications in current and velocity patterns around the dam are anticipated; the discharge of tidal waters during power production will occur in a more turbulent manner due to the reduced cross-sectional area and due to the orifice placement beneath lowest low tide level; the velocity profile will be increased by a lesser degree, but still above normal, when the basin is filled; navigation will be prohibited near the dam because of the turbulent conditions during tidal exchange.
   - current and velocity patterns will be affected to a much lesser degree within the cove (i.e., surface waters and intertidal areas); since the cove's level remains constant during approximately 40% of the time, the velocity profile will have a longer period of stagnant water; the precise impact is difficult to quantify except

to note the positive recreational benefits; however, intuitively, the more tranquil waters during approximately 40% of the time will inevitably allow the establishment of certain communities that are well suited to this behavior.

- during power production, the comparison between natural and modified conditions for the average discharge rate is expressed as follows for the tidal ranges indicated:

TIDAL RANGE(FT)	AVE. DISCHARGE(CFS)	
	NATURAL	MODIFIED
13.3	13,950	7,990
18.1	18,930	10,420
26.2	27,470	12,630

where "ave. discharge" is defined as the volume exchange divided by either the time in production or by the time between high tide to low tide; obviously the modified conditions reduces the average velocity of the impounded waters and also reduces the variation between maximum and minimum velocity; the second statement is attributed to the natural behavior of the tides which has a greater disparity between the currents observed shortly after high tide relative to the maximum currents at mid-tide.

- during power production, the intertidal zone will similarly experience a more uniform and less intense velocity distribution; the effect on intertidal organisms is not specifically known, but intuitively the lower energetics is expected to allow the establishment of communities adaptable to the modified conditions; the existing communities within the modified intertidal zone will not be eliminated, but will be reduced/increased in accordance with their intrinsic ability to respond to the stresses induced by the plant's operation; in this case, the velocity parameter is only one factor affecting the evolving ecosystem.
- during the basin's filling, the velocity pattern will not be affected within the impoundment since the tidal exchange and filling times remain relatively unchanged during this phase of operation; the greatest concern in this case refers to the intertidal zone and to the different velocity pattern observed during power production and the basin's filling; established communities will have two different sets of hydrological parameters during the ebb and flood tides; however, the differences will also have to be considered in terms of the species' inherent abilities to tolerate a wide range of tides (i.e., from neap to spring tides) and to adapt to the operational characteristics of the project.
- estuaries (i.e., two minor streams) and wetlands will not be affected since the highest high tide level will not be exceeded during operation.
- groundwater resources surrounding Half-Moon Cove are not expected to be affected by the increased mean basin level; the complexities of salt water intrusion necessitate sophisticated analyses which was deemed unwarranted by the engineers and scientists involved with project development plans; a brief survey of bordering resi-

dences indicated only a minimal use of groundwater.
- the operation of the tidal project will serve as a positive benefit by controlling erosion on the shoreland during storm surges, especially under the action of certain prevailing winds.

3. Physical Oceanography
   - the proposed operating mode suggests stratification will be limited since some vertical mixing is expected; no reduction in dissolved oxygen is anticipated; sedimentation will not be drastically decreased and turbidity will not increase appreciably since the inflowing velocities will approach pre-operational levels; salinity concentrations will remain constant throughout the water column because the tidal flushing of Half-Moon Cove is considerably greater than the freshwater flux.
   - the flushing time will be reduced during the production mode in accordance with the available tidal range (see Table III-2); the filling process will also be shortened due to the reduction in the tidal range and corresponding reduction in tidal exchange.
   - complications associated with a modification to the tidal resonance phenomena has been dismissed as noted in subsection "c" (effects of construction).
   - no appreciable water temperature increase/decrease is expected due to plant operation; a temperature increase would occur as a result of heat exchange between the exposed mudflats and the incoming tidal water; the reduction in the intertidal zone and a reduction in exposure time will not provide additional opportunities for heating of the mudflats; heating of the water by ultraviolet penetration is expected to be minimal; the larger water volume is also expected to reduce temperature fluctuations; bioponding is expected to minimally increase the summertime water temperature.
   - the bacteria count is expected to remain at its present level since the major physical oceanic properties will be unaltered; increased productivity or the establishment of a different intertidal community is estimated to not adversely affect the bacteria count.
   - since the temperature regime will be only slightly affected, the problems associated with increased icing appears to be minimal and certainly less critical than the normal variations in yearly climatological conditions; however, since the barrage will obstruct ice movement, an especially cold winter might aggravate the impacts (i.e., scouring, light penetration, salinity stratification) within the impoundment; the degree of adverse impact still seems minimal since the intertidal zone has been reduced considerably and the increase in the basin's water capacity are counterbalancing effects.

4. Water and Sediment Chemistry
   - Quoddy Village borders the southeastern segment of Half-Moon Cove and is an existing pollution problem which discharges untreated wastes from approximately 350 people; the operation of the tidal project (i.e., reduced tidal exchange) is not expected to significantly affect the water quality since the reported dissolved oxygen (DO) are at or near saturation level which indicates no apparent impact from the sewage; also the size of Half-Moon Cove

relative to the volume of untreated waste reinforces this conclusion even in light of the reduced tidal exchange imposed by the plant's operation; tentative plans have been prepared for the construction of a treatment plant in Quoddy Village which would discharge the treated waste into Cobscook Bay and not into Half-Moon Cove; the City of Eastport is still awaiting funding for this facility; the intertidal area from Mitchell Point to the easterly entrance of Half-Moon Cove has been closed for many years to shellfish harvesters.

- water quality would be minimally impacted for a short period of time from sedimentation occuring. As a result of the scouring action at the dam site; however, the water quality will also be positively, though minimally, affected by the increased water volume of Half-Moon Cove at low tide.
- the transport property of biologically important nutrients is assumed to be unaffected by the project's operation; the net effect of the reduced tidal exchange on nutrient supply is expected to be temporary and negligible when considered in terms of the existing nutrient level contained within the environment.

5. Climatology
   - no impacts, positive or negative, are associated with the project's operation due mainly to the relatively small size of Half-Moon Cove.
   - the air quality will not be affected by the project's operation since the project represents the utilization of a renewable energy resource which doesn't discharge pollutants into the atmosphere.

6. Ecology
   - in general, the ecological characteristics of the affected area will change in accordance with the parameters (e.g., hydrological, physio-chemical) established by the project's construction and operational plans; however, a certain period of time will be required in order to stabilize the conditions controlling the establishment of a stable environment; in the case of this project, the primary impacts refer to the area within the impoundment and to the modifications resulting from the reduced and altered tidal range; the specific impacts of the project's operation will be expressed in terms of the impacts anticipated for certain species and marine life.
   - the U.S. Fish and Wildlife Service in a coastal characterization study has designted Half-Moon Cove as well as other areas of Cobscook Bay as an important shorebird feeding area for semipalmated plover and semipalmated sandpiper during spring and fall migrations; waterfowl also use the area as a winter feeding area; for an average tidal range, the mode of operation would decrease the intertidal zone from 505 acres down to 124 acres, a loss of 381 acres of intertidal habitat for an impoundment which has a surface area of 795 acres at high tide; since the bird community generally feeds along the upper reaches of the tidal spectrum as the tide recedes, the impacts on the bird-feeding habitat are not deemed significant especially when considered in terms of the availability of other suitable sites within Cobscook Bay; the impoundment will continue

to serve as a feeding area which has been reduced in size, but still productive as a food source for the various bird species.

- Half-Moon Cove is also a breeding area for several species of birds; with plant operation, the high water level will not be significantly changed; since the loss of saltwater marsh area and wood areas will be minimal, little disturbance of breeding habitat is expected.
- the impacts on the breeding/nesting activities of bald eagles, an endangered species, has been discussed with staff members of the U.S. Fish and Wildlife Service; since Half-Moon Cove is not located near an identified nesting area, no adverse effects on the existing bald eagle population are attributed to the operation of the project.
- the species composition and abundance of phytoplankton and zooplankton are expected to change as a result of the project's operation; the extent of these modifications will depend on the alteration of the flushing rates, tidal amplitudes, turbidity and temperature regimes within the impoundment; from a qualitative interpretation, the planktonic life within the impoundment is expected to increase in abundance, but decrease slightly in diversity; the principal basis for this statement is related to the formation of a euphotic zone with an expanded surface area (i.e., at low tide) and with an increased water storage capacity; assuming that planktonic productivity is light controlled, the modified tidal regime and the lowered turbidity index are expected to increase productivity in the expanded upper layer of the impoundment; a decrease in the diversity of species is anticipated since the modification of the hydrological and physio-chemical parameters will enable certain species to increase in abundance and also cause less adaptable species to decrease in number or possibly disappear from Half-Moon Cove; these long-term changes will occur eith the completion of the basin's stabilization; plankton is considered as an important base element of the food chain in the Cobscook Bay region.
- the benthic invertebrate population will be affected in several ways; the area covered by the dam will be permanently lost as a benthic habitat; but, the surface area of the dam will create a new habitat for some benthic species; if periodic dredging is necessary, destruction of benthic organism and habitat will occur in the area of dredging; changing velocities and current patterns may cause scouring creating a further loss of habitat.
- the existing intertidal zone within the impoundment will experience a drastic decrease in surface area; the lower reaches of the natural tide spectrum (i.e., area below the lowest low tide level as defined by the mode of operation) will become submerged lands and gradually transform into a benthos colony similar in species composition and abundance as communities that presently exist in adjacent submerged sections; the new intertidal zone will also gradually transform into an area with a spatial distribution of flora and fauna similar to the natural environment except for a substantially different vertical range and a slightly altered exposure regime; the modified

project, access to the site except for the increased traffic, will not pose an additional burden to the local landowners; integration with the local utility will be done along the existing transmission corridor.

- recreational utilization of Half-Moon Cove is negligible; several boats enter and leave the tidal basin during a typical week; the primary purpose of navigation is related to pleasure boating and mooring by bordering landowners; commercial/sport fishing is virtually nonexistent; the impoundment will create a deeper and controlled basin better suited for boating, but with no access to Cobscook Bay due to the exclusion of a navigational lock from the project's design; the increased water temperature during the summer might make the impoundment more attractive as a swimming area, an activity presently restricted to daring individuals; in summary, the project's operation is considered as a positive recreational impact.
- bordering landowners will have a low tide level closer to the shoreline; a positive benefit can be attached to this effect, if a person prefers more water nearer their home or site; on the other hand, someone else might object due to the loss of an ever-changing environment characterized by a far-ranging tidal exchange; aesthetically, the impoundment will resemble a reservoir, as opposed to a rapidly changing body of water with a well defined emptying/filling schedule; at the dam site, the turbulent waters will indicate the dynamic process involved in power production.

8. Social and Economical
   - the income from the project will be used by the Passamaquoddy Tribal Council to improve public services or for other worthwhile projects (e.g., economic development).
   - the operation phase of the Half-Moon Cove Tidal Project will require a minimum of manpower as it will be an unattended automated plant. This can be accomplished by a program developed from the annual predictability of the tides. Manpower will thus be required for such tasks as janitorial services, grounds upkeep (seasonal and/or intermittent) and periodic inspection. This labor force can be recruited from the local labor force. Added to this will be periodic maintenance of equipment which again will be intermittent but may require outside skills.
   - being a singular project, and possibly the first one in the United States, its uniqueness can have tourism potential. The area is handicapped by its isolation and limited access, but these are problems that an aggressive committee may overcome. For example, it could be a keystone of a well prepared recreation plan utilizing the other natural resource features of the area.
   - it is planned to incorporate a roadway across the top of the dam; this would replace the Old Toll Bridge (now washed out) and restore the old highway for use as a connection between Perry and Eastport.
   - if tourism can be developed, it can become the base for new or expanded service facilities, (e.g., motels, restaurants, gift shops, with opportunities for creative artisans, etc.) with economic benefits.

- the objective of the project will be the significant benefit obtained from a furnishing of reduced cost of energy; the annual generation of 37,276,800 kwh would far exceed the demands for the towns of Eastport, Lubec, Perry, Pembroke, and Dennysville (using 300 kwh per month per family) by direct use or transfer arrangements with Bangor Hydroelectric.
- non-economic per se but prestigous would be its place as a research center for the exploration and testing of the multitude factors and features associated with the development of tidal power. It well can become a mecca for academia and the engineering field.

(3) Decommissioning: Current Regulations

This issue has been addressed before and will depend greatly on the development of ancillary uses of the dam / barrage.

E. Termination or Abandonment
Project termination or abandonment is a decision which will depend on the condition and utilization of the impoundment area. Basically, two choices exist: (1) maintain the modified tidal regime, or (2) revert to the natural emptying/filling process. In any case, the road would continue to serve as a second access route between Perry and Eastport. If the environment has stabilized and if recreational benefits are being realized, the plant will be modified to produce the same tidal regime within the impoundment. However, if the tidal basin is still experiencing a transition phase with no accompanying recreational utilization, the gates will then be opened allowing the retransformation to natural conditions. Further analysis would be required if the implications aren't obvious or easily adoptable.

§ 5.6 (d)(3)(i)(D) – Protecting / Mitigating Impacts & Enhancing Resources

Once again, information is provided in the form of historical data as denoted by a heavy border of dashed lines. For this subsection, information from the Quoddy Bay LNG proposal does not apply to this discussion.

As previously noted during the description of the proposed mode of operation for the facility, the main impact is attributed to the reduction in the tidal range within the impoundment and the decrease in access to Half-Moon Cove. The permanent transition of an intertidal zone into submerged lands and the creation of the dam's footprint at the entrance to Half-Moon Cove are considered as unavoidable consequences of the project's construction and operation. These two issues will have to be analyzed during the regulatory review of project benefits and impacts. In our opinion, the existing ecosystem has sufficient flexibility to adapt to these changes within the "low spring tide zone".

The issue of accessibility will be analyzed in subsequent sections when discussing specific natural resource impacts.

(D) A description of any existing or proposed project facilities or operations, and management activities undertaken for the purpose of protecting, mitigating impacts to, or enhancing resources affected by the project, including a statement of whether such measures are required by the project license, or were undertaken for other reasons. The type and amount of the information included in the discussion must be commensurate with the scope and level of resource impacts caused or potentially caused by the proposed project. Potential license applicants are encouraged to provide photographs or other visual aids, as appropriate, to supplement text, charts, and graphs included in the discussion.

The installation of a filling / emptying gate in the rockfill dam between Pleasant Point and Carlow Island has also bee proposed as a method to control the tidal waters of Half-Moon Cove to optimize electrical generation and to also improve the water quality of the tidal basin as a mitigative measure. The feasibility of this element of design plans is still under consideration.

iii. recommendations for mitigation of impacts

The Maine Department of Marine Resources has recommended that a fishway will not be needed for the Half-Moon Cove project (see App. X-2).

Responses to the comments prepared by the U.S. Fish & Wildlife Service appear in App. X-7 . In brief, the developer agrees to the mitigative measures recommended by the U.S. Fish & Wildlife Service:

- provide enhanced shorebird feeding opportunities to mitigate the losses incurred by the proposed mode of operation; the exact amount of enhancement to be determined by a careful evaluation of the importance of Half-Moon Cove to the migrating shorebird population; however, the impacts, in our opinion, can be successfully mitigated with due consideration to particular circumstances in feeding habits and regional feeding habitat,

- provide sufficient protection to prevent marine mammals from passing through turbines (e.g., stop-logs),

- adopt plans for environmental research within a year of issuance of a F.E.R.C. license in direct coordination with fisheries and wildlife agencies,

- compensate for losses to the commercial marine resource value of Half-Moon Cove (i.e., clamming, worming) by the support of a conservation and management program agreed to in principle during deliberations on the project's Submerged Lands Lease with the Maine Department of Conservation (see App. X-1); an initial amount of $ 25,000 per year was established as the the project's environmental cost,

The Passamaquoddy Tribal Council at the Pleasant Point Reservation proposes to develop the Half-Moon Cove site with no further plans to develop other tidal power sites in Cobscook Bay or Passamaquoddy Bay. The decision to select the prescribed mode of operatin represent a careful balance of environmental, engineering, and economic factors as stated in Sec. 10, Exhibit E.

Responses to the comments prepared by the National Marine Fisheries Service appear in App. X-9 . Some of the mitigative measures are covered in the response to the U.S. Fish & Wildlife Service and will not be repeated, but in addition the developer agrees to the mitigative measures summarized below:

- provision to remove the overburden on the Eastport side of the project site before the construction of the rockfill dike; the decision to remove the over-

burden before the placement of the Perry cofferdam or to place sill curtains on the Eastport side will be determined during the applicant's application for a dredging and excavation permit from the U.S. Corps of Engineers,

- provisions for the removal of entrapped mammals will be adopted in agreement with the National Marine Fisheries Services,
- use of deflectors, diffusers, or fish weirs will be coordinated with the appropriate agencies during the final engineering phase,

Other agencies who commented on the project as referenced in Appendix __X__ did not require a consideration of mitigative measures different than the ones summarized in this section.

iv. mitigative measures

The mitigative measures outlined in subsection (iii) above are conceptual in nature and do not involve details than fc more common mitigation structures (e.g., fishway). The cost of adopting mitigative measures has been defined in the case of impacts to the impoundment's marine resources and will be included in project costs when final determination is made from the final coordination project.

The cost of the scientific research program associated with the construction and operation of the Half-Moon Cove project will also be considered as part of the financing package.