



**Conceptual Design to Recycle Water  
in Post-Panamax Locks  
Cost Estimation**

**Diseño Conceptual para el Reciclaje  
de Agua en las Esclusas  
Pospanamax  
Estimado de Costo**

**CONSORCIO POST PANAMAX**

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**Resumen Ejecutivo**

# 1 Executive Summary

This report deals with the second phase of the conceptual design to recycle water in Post Panamax locks, at the Pacific side of the Panama Canal. This second phase concerns the electro-mechanical and civil engineering work, and cost estimation. The first phase deals with the hydraulic components of such system and are reported in R-HY-002-B.

The following three scenarios have been investigated:

- Direct Pumping (from Pacific Ocean to Gatun Lake)
- Semi Direct Pumping (from a lower pond to Gatun Lake)
- Pond to Pond Pumping (from a lower to an upper pond).

These 3 scenarios have been worked out for 4 lock configurations and three operational modes. The three scenarios are the following:

- Triple lift lock system with 3x3 Water Saving Basins (WSB)
- Triple lift lock system without WSB
- Double lift lock system with 2x2 WSB
- Double lift lock system without WSB

Following modes of operation have been taken into account:

- 1-5 lock operations a day
- 5-10 lock operations a day
- 10-15 lock operations a day

It has been shown during the first phase of the study that all scenarios are feasible from the technical point of view. Other constraints, such as environmental, are not considered nor evaluated as they are not part of the scope of work.

The electromechanical components required for the pumping system are highlighted in reports R-EM-01 and 02. These components consist mainly of vertical tube pumps, butterfly valves, pumping stations with electrical equipment and monitoring equipment. An estimation is given of the energy consumption in function of the required pumping rates.

This report R-CW-02 on civil works and cost estimation describes the different civil engineering components of the systems, which are mainly the following:

- Upper pond with dam and spillway
- Lower pond
- Pumping stations

- Penstocks
- Connecting culverts between ponds and locks (2)

Finally, a construction schedule and cost estimation has been prepared.

The base line scenario with direct pumping is definitely the less complicated and can be realized in a construction period of nearly two years. It does not require adaptations to the lock system as it pumps independently water from the Pacific to Gatun Lake.

The two other base line scenarios are more complicated as the pond(s) have to be connected to the lock chamber(s), which requires an adaptation to the lock culvert system, and this has to be integrated in the lock construction. This means that any decision on this type of recycling has to be taken before basic and detailed design.

Both scenarios can be realized in a period of nearly 3 years, but demand important activity in the close vicinity of the locks, which will be in operation. Boring techniques have therefore been envisaged to realize the connecting culverts.

As far as the penstocks are concerned, as they are an important part of the investment due to the length, have been foreseen as steel large diameter pipes as this is the most common practice. Nevertheless, since steel prices depend on economical factors that are difficult to predict and seem to become unfavorable at the moment of editing of this report, it should be noted that the penstock can as well be constructed in reinforced concrete.

The cost estimation for the total of construction work and electromechanical equipment is given below for the three base line scenarios and the two lock considered configurations, with and without WSB, and assuming maximum operation mode:

Base line scenario	Lock Configuration			
	3Lift + WSB	3Lift without WSB	2Lift with WSB	2Lift without WSB
Direct Pumping	\$34.328.362	\$78.414.978	\$55.055.223	\$108.923.550
Semi Direct Pumping	\$176.973.087	\$214.902.238	\$206.345.305	\$243.426.601
Pond to Pond Pumping	\$274.658.459	\$315.482.051	\$317.186.663	\$361.891.572

Maintenance end operation cost (M&O) can be estimated yearly at 1% of the investment cost.