Harnessing Energy and Water in The Salton Sea (Segm. II)
(Harnessing Hydro Power)

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Keywords

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ABSTRACT

The Salton Sea in California is a terminal lake with reduced inflow from the Colorado River as a result of the water transfers related to the Quantification Settlement Agreement (QSA). The Lake is shrinking and exposing the receding shoreline (toxic playa) to the elements and facing oncoming environmental disaster.

The presented proposal includes an architectural design that harmoniously incorporates several patented technologies into a self-sustaining organism. It is a long-term solution for the restoration of the Salton Sea.

The presented proposal includes several options based on the same concept: 1) Dividing the Lake into three sections; 2) Importing seawater from the Ocean; 3) Harnessing prevalent geothermal energy.

In this segment (II), the emphasis is on Harnessing Hydro Power during the import of seawater from the Ocean. The presented system for importing seawater is the essential phase for harnessing geothermal energy and for the restoration of the Salton Sea, CA, although is not limited to the Salton Sea project.

Contemporary pumping stations and hydroelectric power plants are expensive and have restrictions on location, capacity, and access. The presented proposal for importing seawater has several “In-line-Pumps” as segments of the pipeline for uphill routes and has several “In-Line-Generator” as segments of the pipeline for generating electricity on downhill routes. This system also has “Split and Join” and “Delta” mini Hydroelectric Power Plants on downhill routes.

1. Introduction

The presented system for importing seawater is the essential phase for harnessing geothermal energy and for the restoration of the Salton Sea, CA, although is not limited to the Salton Sea project.

Contemporary pumping stations and hydroelectric power plants are expensive and have restrictions on location, capacity, and access. The presented proposal for importing seawater has several “In-line-Pumps” as segments of the pipeline for the uphill routes and has several “in-line-generator” as segments of the pipeline for generating electricity on downhill routes (See Fig. 1-4). This system also has “Split and Join” and “Delta” mini–Hydroelectric Power Plants on downhill routes. Downhill routes of the pipeline can be built using several cascades with “split and join” mini–Hydroelectric Power Plants to avoid the buildup of extreme hydrostatic pressure in the pipeline especially in the last section of the final downhill routes (See Fig. 4 and 5). The system uses primary and secondary “In-Line-Generators” (See Fig. 6-8). The primary “In-Line-Generators” are the first generators after the cascade drop with less exposed spiral blades inside the shaft/pipe generating electricity and allowing fluid flow to continue to the subsequent smaller diameter pipes with slightly lesser speed. After exiting the primary “In-line-generators”, the fluid flow is split into two subsequent smaller branches with smaller “In-line-generators” which have more exposed spiral blades inside the shaft/pipe and lesser opening in the middle. By splitting fluid flow into smaller branches with a lesser speed of fluid flow in each subsequent branch, it increases the efficiency of harnessing kinetic energy and at the same time providing the same volume of water exiting the pipeline and entering the Lake as the volume of water exiting the primary “In-Line-Generators”. To accommodate the same volume of water exiting the downhill pipeline and the “Delta” mini–Hydroelectric Power Plant, the same volume of water needs to enter the pipeline at the uphill route from the Ocean. That is achieved by having several pipelines on the uphill route with lesser fluid speed through them.

1.1 Preliminary Cost Estimate for the Pipeline Route # 1: From Gulf of California – San Felipe - Mexicali, Mexico, - to the Salton Sea.

Elevation to overcome is 35‘ (10.6 m).

Pipeline distance is about 150 miles.

The range of cost today of installed pressure pipe of 48-inch diameter in various terrains is about $600 – $1,000 per linear foot.

Route # 1 has about 150 miles with preferred topography which has an advantage in pipeline cost. Let’s assume $600 per linear foot.

The cost of one mile 5,280‘ x $600 = $3,168,000.

$3,168,000 x 450 miles relatively flat terrain (50 miles x 5 pipelines + 50 miles x 3 pipelines 50 miles 1 pipeline) = $1,425,600,000.

Because of new product development, plus several pumping stations which will work temporally, plus final “delta” mini–Hydroelectric Power Plant on the final route, plus building several freeway underpasses, plus right-of-way permits, preliminary and final design, plus unexpected charges such as price increase, the final cost might increase about 20%. If such unexpected charges do not happen, then the money will be transferred to a reserve account or will be distributed to related projects if needed, or towards reduction of the final cost of the project.

$1,425,600,000 x 20% (unexpected factor) = $285,120,000

- ⇨ $1,425,600,000 + $285,120,000 = **$1.710,720,000.**

1.1.1 Estimated maintenance expenses for pipeline Route #1

Estimated Maintenance Expenses for the pipeline Route #1: **$2,000,000.**

1.2 Preliminary Estimate of Energy Needed for the Pipeline Route # 1: Importing Seawater from the Gulf of California – Corridor: San Felipe - Mexicali, Mexico, to the Salton Sea.

Pipeline distance is about 150 miles.

Free Fall 70 meters:

Diameter of pipe is 48”

$S = \frac{1}{2} g \times t^2$;

S = Vertical distance;

g = gravity = 9.81;

t = time

A = Area of the cross-section of the pipe.

$A = \pi r^2$ = 3.14 x (2x2) = 12.56 f^2

12.56 f^2 / 9 = 1.39 y^2 = 1.16 m^2

Free Fall values at 70 meters drop:

$S = \frac{1}{2} g \times t^2$

$70 = \frac{1}{2} \times 9.81 \times t^2$

$t^2 = 140 / 9.81 = 14.27$

$t = \sqrt{14.27} = 3.77$ seconds

Speed of water at nozzle at the bottom of the vertical fall at 70 meters:

V = Velocity (Speed)

$V = g \times t$

V = 9.81 x 3.77 = 37.05 meters per second (41.01 y/s)

The volume of seawater entering the lake through one pipe with diameter 48" at speed of 41.0 y/s (yard per second) is: 1.39 y^2 x 41.0 y per sec. = 57.00 y^3 x (31,536,000 seconds in a year) = 1,797,674,900 y^3 = **1,114,261 acre-foot per year.**

The volume (mass) of water needed to balance the evaporation of the central section of the Lake is about 1,000,000-acre foot per year.

V = velocity => 7.4 m/s = 8.2 y/s is the speed that is needed to pump water from the Ocean through each of 5 pipelines of 48" diameter to accommodate the volume of seawater entering the Lake through one pipe with diameter 48" at speed of 41.0 y/s (yard per second).

The volume (mass) of water (42,720 kg) per second exiting the primary in-line-generator at speed of 37 m/s (41 y/s) and after "delta" mini hydroelectric power plant entering the Salton Sea is the same volume (mass) of water (42,720 kg) per second entering 5 pipelines in Gulf of Mexico at speed of 7.4 m/s (8.2 y/s).

Kinetic Energy:

For 70-meter drop from the top of the hill to the surface of the lake

The surface of the Lake is 70 meters below the ocean level.

Velocity (Speed) of the water at the surface of Lake or at nuzzle (in-line generator) is 37.05 m/s (41.01 y/s)

$Ek = \frac{1}{2} M \times V^2$

Ek = Kinetic Energy

M = Mass

V = Velocity

$M = Ek \times 2/ V^2$ => M = 1.16 m^2 x 37.05 m/s = 42.98 => 42.98 x (994kg = weight of water at 100 ºF) = 42,720kg

(42,720 kg is the volume (mass) of water passing through pipeline per second).

$Ek = \frac{1}{2} M \times V^2$ = ½ x 42,720 kg x (37.05 x 37.05) => ½ x 42,720 kg x 1,372.7

=> ½ 58,641,744 = 29,320,872 MWs in period of one hour it is 29.3 MWh.

Efficiency factor usually used is 15% loss => 29.3 MWh x 0.85 = 24.9 MWh.

At this early stage without final testing of the new system, it is realistic to expect that by using "delta" mini hydroelectric power plants which harness energy after the main turbine (Primary In-Line-Generator) using mass and speed of fluid (no gravity) can be harnessed an additional 10% of energy which is about 2.4 MWh which end up to about **27.3 MWh**.

1.3 Preliminary Estimate for Revenue generated from hydropower of the Pipeline Route # 1: Importing Seawater from the Gulf of California – Corridor: San Felipe - Mexicali, Mexico, to the Salton Sea.

27.3 MWh x $60 = $1,638 per hour.

$1,638 x 24 hours = $39,3210 per day.

$91,310 x 365 days = **$14,348,880** per year.

- ⇨ Estimated Revenue: $14,348,880 - $2,000,000 (maintenance) = **$12,348,880.**

It is realistic to expect that starting with 5 pipelines with a diameter of 48" and speed of seawater 7.4 m/s (8.2 y/s) at the Gulf of California (near San Felipe) and then gradually reducing the number of pipelines to 3 pipelines and then 1 pipeline through several sections of 50 miles (50 miles x 5 pipelines + 50 miles x 3 pipelines + 50 miles 1 pipeline (See GIG. 1) in a few weeks the speed of seawater through the pipeline will be stabilized and will continue without using initial in-line-pumps at the entrance of the pipeline system.

1.4 Preliminary Cost Estimate and Energy Needed for the Pipeline Route # 2: Importing Seawater from Long Beach – Whitewater - to the Salton Sea.

Elevation to overcome is 2,700' (823 m).

The pipeline distance is about 150 miles.

There is "Inland California Express" - Existing Pipeline – 60-year-old - diameter 16" for crude oil - 96 miles long from Long Beach to Whitewater area. The Questar Company owns the pipeline. The pipeline is not operational now. The Questar Company has "Right of Way" and is willing to sell it. Emphasis is on the "Right of Way".

The presented new pipeline is 48" in diameter. Downhill routes of the pipeline can be built using several cascades with "split and join" hydropower plants to avoid the buildup of extreme pressure in the pipeline especially in the last section of the final downhill route. By using several cascades with several "split and join" and "delta" hydropower stations this system can harness more kinetic energy.

1.5 Preliminary Cost Estimate for the Pipeline Route # 2: From Long Beach – Whitewater - to the Salton Sea.

The range of cost today of installed pressure pipe of 48-inch diameter in various terrains is about $600 – $1,000 per linear foot.

ADDENDUM

Route # 2 has about 150 miles with some areas with challenging topography, therefore here is selected the cost of $900 per linear foot. The change from the original paper is the price of $600 per linear foot of the pipeline to the price of $900 per linear foot.

The cost for one mile: 5,280' x $900 = $4,752,000.

$4,752,000 x 450 miles relatively flat terrain (50 miles x 5 pipelines + 50 miles x 3 pipelines 50 miles 1 pipeline) = $2,138,400,000.

$2,138,400,000 x 20% (Permits, Design preliminary and final, unexpected factor = $427,680,000)**.**

$2,138,400,000 + $427,680,000 = **$2,566,080,000.**

Purchase of "Right-Of-Way" (assumption about $500,000,000).

- ⇨ $2,566,080,000 + $500,000,000 = $3,066,080,000.

Preliminary Cost Estimate for the Pipeline Route # 2 is **$3,066,080,000.**

1.5.1 Estimated Hydro energy Generated:

Estimated Hydro energy Generated: deficit **-**142.1 MWh (See Segment *1.6*)

1.5.2 Estimated Maintenance Expenses.

Estimated Maintenance Expenses: - **$2,000,000.**

1.5.3 Siphon system – feasibility - calculation:

Natural flow thru siphon is here shown in FIG. 2. We can use this known principle for approximately 10-meter (33 feet) maximum difference between sea level and height to overcome.

The calculation below shows capacity of water throughput flowing thru the pipeline of diameter of 48" where there is a difference (drop in height) of 70 meters.

$$Q = \frac{\pi}{4} D^2 \text{ x } [(\frac{2g\Delta h}{\varepsilon})^{\frac{1}{2}}] \ (m^3/\text{sec})$$

$$Q = \frac{\pi}{4} 1.22^{\,2}[\left(\frac{2\ x\ 9.81\ x\ 70}{3.1}\right)^{1/2}]\ \ (m^3/\text{sec})$$

ε = 1.9 + 0.019 $\frac{70.00+7.00(height\ to\ be\ overcome)}{1.22\ (m)}$=

3.099 = parameter value in a pipe flow resistance

calculation formula…

ε= 3.099 approx 3.1

$Q = \frac{\pi}{4} 1.48\ \ (443.03)^{1/2}$

$$Q = \frac{\pi}{4} 1.48\ \ (\ 21.04\ ) = 24.45\ \ m^3/sec$$

$Q = \frac{\pi}{4} D^2$ x $[(\frac{2g\Delta h}{\varepsilon})^{1/2}]\ \ (m\text{^}3/sec)$

ε = 1.9 + 0.019 $\frac{(100.000)}{1.22\ (m)}$ =ε = this is a

The parameter value in a pipe flow resistance calculation and for example if pipe were 100 km long route = 1,559.2 approximately.

$\boldsymbol{\varepsilon}$**= 1,600**

And that whole route has 70.00 meters drop

(height difference).

$$Q = \frac{\pi}{4} D^2 \text{ x } [(\frac{2g\Delta h}{\varepsilon})^{1/2}]\ \ (m^3/sec)$$

$$Q = \frac{\pi}{4} 1.22^2 \text{ x } [\left(\frac{2\ x\ 9.81\ x\ 70.00}{1600}\right)^{\frac{1}{2}}] = 1.09(m^3/sec)$$

The calculations above just show what is the capacity of the water flow thru this pipe size of diameter of 48" and how much we lose on resistance because of length of route…so because of natural water flow resistance in the pipes we would need to have pumps pumping a water…

Since there is no a big obstacle (mountain) to overcome on Route #1, (only certain area about 10 feet (3 meters)), the most economical solution would be to cut off certain area where needed and dig trench to put in the 48" diameter pipe or pipes for a certain distance on preferred corridor (path) to make height for the pipeline to overcome elevation preferably of only 20-25 feet, or less, over "sea/ocean water line".

Any concern related to waterline height change as a result of the Ocean's tide would still allow us to use the same principle the whole day, at the time of the day when the sea water level is at the lower line that we call "below normal sea water line". To keep the flow identical throughout a day, and to have necessary flow and volume the pumps would need to work. Several in-line pumps are recommended (See Figures 11 and 12).

This concept shows that once we deliver water through the pipes over that flat portion of the route, we would be able to generate electricity by that same water flowing down through the natural slope 70 meters that we have. With this system (concept) we would be able to return some of electricity that we have used but project like this with all its phases as this comprehensive concept offers would generate way more then we have spent.

To bypass (avoid) restricted biosphere zone at Northern section of the Sea of Cortez needs to be laid down at the bottom of the Sea of Cortez bunch of pipelines providing allowed seawater to the In-line Pumps at the shoreline. (See Figures 9 - 12).

The benefits of this concept (system) are:

1) Positive concept, structure, and outcome in **ecological** sphere, especially filling up Laguna Salada, establishing large body of water and reestablishing flow of water from Colorado River to Sea of Cortez.
2) Positive concept, structure, and outcome in **clean renewable energy** sphere.
3) positive concept, structure, and outcome in a **net financial and economic** sphere.

1.6 Preliminary Estimate of Energy Needed for the Pipeline Route # 2: Importing Seawater from Long Beach California to the Salton Sea.

Free Fall values at 823 meters + (70 meters Ocean to Lake difference) = 893 meters

On this route can be used 3 cascades each with 297 m drop and 9 uphill pumping stations.

Free Fall:

$S = ½ g \times t^2$.

S = Vertical distance.

g = gravity = 9.81.

t = time

Free Fall values at 297 meters

$S = ½ g x t^2$

$297 = ½ x 9.81 x t^2$

$t^2 = 594 / 9.81 = 60.55$

$t = \sqrt{60.55} = 7.78$ seconds

Speed of water at nozzle at the bottom of the vertical fall at 297 meters:

V = Viscosity (Speed)

V = g x t

V = 9.81 x 7.78 = 76.33 m/s = (83.47 y/s).

The volume of seawater entering the lake through one pipe with diameter 48" at speed of 83.47 y/s (yard per second) is: 1.39 y^2 x 83.47 y per sec. = 116 y^3 x (31,536,000 seconds in a year) = 3,658,176,000 y^3 = **2,267,464 acre-foot per year**.

The volume (mass) of water needed to balance the evaporation of the central section of the Lake is about a 1,000,000 acre-foot per year.

V = velocity => 15.26 m/s = 16.7 y/s is the speed that is needed to pump water from the Ocean through each of 5 pipelines of 48" diameter to accommodate the volume of seawater entering the Lake through one pipe with diameter 48" at speed of 76.33 m/s = (83.47 yards per second).

The volume (mass) of water (88,008 kg [42,720 kg]) per second exiting the primary in-line-generator at speed of 76.33 m/s = (83.47 y/s) and after the "delta" mini hydroelectric power plant entering the Salton Sea is the same volume (mass) of water 88,008 kg per second entering 5 pipelines in Long Beach at speed of 15.26 m/s = (16.7 y/s).

Kinetic Energy

For 297 m drop (first cascade) to the first in-line-turbine /generator.

Speed of the water at the exit of first in-line-generator is 76.33 m/s = (83.47 y/s)

$Ek = ½ M x V^2$

Ek = Kinetic Energy

M = Mass

$M = Ek x 2/ V^2$

M = 1.16 m^2 x 76.33 m/s = 88.54 m^3 => 88.54 x (994kg = weight of water at 100 ^oF) = 88,008kg

(88,008 kg is the volume (mass) of water per second).

Ek = ½ M x V^2 = ½ x 88,008 kg x (76.33 m/s x 76.33 m/s) => ½ x 88,008 kg x 5,826 m/s

=> ½ 512,734,600 = 256,367,300 MWs => in period of one hour it is 256.36 MWh.

Efficiency factor usually used is 15% loss => 256.36 MWh x 0.85 = 217.90 MWh.

Three such cascade drops add to 217.90 MWh x 3 (cascade drops) = 653.7 MWh.

At this early stage without final testing of the new system, it is realistic to expect that by using "split and join" and "delta" hydropower plant which harness energy after fluid leaves the primary In-Line-Generator (main turbine) using mass and speed of fluid (no gravity) can be harnessed at least additional 10% of energy which is about 65.3 MWh. In this case, it ends up to about **719.0 MWh.**

The energy needed to transport the same amount of water through uphill pipeline section(s) which in this case (Route # 2 elevation 2,700' (823 m):

EP = M x g x h = 88,008 kg x 9.81 x 823 m = 710,544,020 MWs in an hour it is 710.5 MWh.

Efficiency factor is used **20%** => 710.5 MWh x 1.2 = 852.6 MWh.

Energy Net for Route # 2: 719.0 MWh – 852.6 MWh = **-142.1 MWh.**

142.1 MWh will be transferred from solar generated energy (See Segment (III)).

1.7 The monetary value of 142.1 MWh transferred from solar generated energy:

142.1 MWh x $60 = $8,526 per hour.

$8,526 per hour x 24 hours = $204,624 per day.

$204,624 per day x 365 days = $74,687,760 per year.

- ⇨ Estimated Revenue: deficit **-** $74,687,760 + (- $2,000,000 maintenance) = -$76,687,760.
- ⇨ Estimated Revenue: deficit **- $76,687,760.**

ADDENDUM

(The section "2" below is added later after the submission of the original papers.)

2. Preliminary Cost Estimate for the pipeline system for irrigation for farmland Southern area of the Salton Sea:

The presented proposal shows the south area from the Lake (from the Lake to the border with Mexico) having three main pipelines (central, western, and eastern) and numerous perpendicular ribs lines (See segment I, FIGS. 3, 4, 5).

The rough estimate of the length of all together pipelines is about 870 miles (40 miles West line + 50 miles Central line + 60 miles eastern line = 150 miles + (24 ribs lines x 30 miles = 720 miles) => 870 miles.

2.1 Preliminary Cost Estimate for the pipeline system for irrigation for the farmland area Southern from the Salton Sea:

The summary of the length of the pipeline system for irrigation for the farmland area Southern from the Salton Sea is about 870 miles.

The range of cost today of installed pressure pipe of 48-inch diameter in various terrains is about $600 – $1,000 per linear foot.

Because of preferred topography, a relatively flat terrain in this area, which has an advantage in pipeline cost it is selected $600 per linear foot.

One mile 5,280‘ x $600 = $3,168,000 per mile.

Preliminary cost estimate for the pipeline system for irrigation for the farmland area Southern from the Salton Sea is $3,168,000 x 870 miles = **$2,756,160,000.**

2.1.1 Preliminary Estimate for Energy Generated from hydropower of the pipeline system for irrigation for the farmland area Southern from the Salton Sea:

The topography of the terrain from the border with Mexico to the Salton Sea is about an 8% slope. The elevation of the Mexicali and Calexico (cities on the border) is about 10-15 feet above the Ocean. The Salton Sea is -220 feet below the Ocean.

The West line of the pipeline system for irrigation is parallel with the section of the pipeline for importing seawater Route #1. Therefore, for easier calculation, here are used the values calculated earlier in section (1.2) “The volume of seawater entering the lake through one pipe with diameter 48” at speed of 41.0 y/s (yard per second) is: 1.39 y^2 x 41.0 y per sec. = 57.00 y^3 x (31,536,000 seconds in a year) = 1,797,674,900 y^3 = 1,114,261 acre-foot per year”. Energy generated is about 27.3 MWh.

The surface of the South Section of the Lake is about 10% of the surface of the whole Lake. Therefore, the volume (mass) of water needed to balance the evaporation of the South Section of the Lake is about 120,000 acre-foot per year.

The South Section of the Lake is supplied with water from All-American Canal near the border with Mexico. The needed water for farmland is about 200,000 acre-feet per year. The water

120,000 acre-feet per year entering the South Section of the Lake can be harnessed with the "Delta Power Plant".

Energy generated at enter to Southern Lake is about **2.73 MWh**.

<u>**2.1.2** Preliminary Estimate for Revenue generated from hydropower of the pipeline system used for irrigation for the farmland area Southern from the Salton Sea:</u>

Estimated Revenue Generated**:** **2.73 MWh** x $60 = $163.8 per hour.

$163.8 x 24 hours = $3,930 per day;

$3,930 per day x 365 days = $1,434,888 per year.

- ⇨ Estimated Revenue Generated**: $1,434,888 per year**.

<u>**2.1.3** Preliminary Estimate for Maintenance Expenses for the pipeline system for irrigation Southern of the Salton Sea:</u>

Estimated Maintenance Expenses: **-$2,000,000.**

3. Preliminary Cost Estimate for the pipeline system for irrigation for farmland Northern area of the Salton Sea:

3.1 Preliminary Cost Estimate for the pipeline system for irrigation for the farmland area Northern from the Salton Sea:

Since the farmland area Northern of the Salton Sea is about half of the farmland area Southern of the Salton Sea, the cost estimate for the pipeline system is simply divided on half.

Preliminary cost estimate for the pipeline system for irrigation for the farmland area Northern from the Salton Sea:

$2,756,160,000 ÷ 2 = **$1,378,080,000.**

<u>**3.1.1** Preliminary Estimate for Maintenance Expenses for the pipeline system for irrigation Northern of the Salton Sea:</u>

Estimated Maintenance Expenses: **-$1,000,000.**

<u>**3.1.2** Preliminary Estimate for Energy Generated from hydropower of the pipeline system used for irrigation for the farmland area Northern from the Salton Sea:</u>

It is not expected generation of hydropower from the pipeline system used for irrigation for the farmland area Northern from the Salton Sea because the “fall” is not sufficient.

4. SUMMARY:

<u>Route #1</u>

Pipeline cost estimate: $1,425,600,000.

Added about 20% for a new product Development; Permits, Preliminary and Final design; Several Pumping stations; Several freeway Underpasses; Right-Of-Way permits; DELTA hydroelectric power plant.

$1,425,600,000 + (20% = $285,120,000) = $1,700,000,000.

- ⇨ Pipeline cost estimate **$1.7 Billion.**

The volume of water imported: **1,114,261** acre-feet per year.

Kinetic Energy generated: **27.3 MWh.**

Revenue generated: $14,348,880 per year.

Maintenance Expenses: **-$2,000,000.**

- ⇨ Revenue generated: **$12,348,880.**

<u>Route #2</u>

Pipeline cost estimate:

$2,138,400,000 + (20% = $427,680,000) = $2,566,080,000.

Purchase of Right-of-Way: $500,000,000.

- ⇨ Pipeline Cost Estimate: **$3,066,5080,000**.

The volume of water imported: **2,267,464** acre-feet per year.

Maintenance Expenses: **-$2,000,000.**

The Hydro energy generated: 710.5 MWh

Efficiency factor is usually 15%, but we are using **20%** => 710.5 MWh x 1.2 = 852.6 MWh.

Energy Net for Route # 2: 719.0 MWh – 852.6 MWh = **-142.1 MWh.**

142.1 MWh will be transferred from solar generated energy (See Segment (III)).

- ⇨ The Hydro energy generated: Deficit **-142.1 MWh.**

The Cost Estimate for Pipeline System for the Irrigation of the Farmland Southern Area of the Salton Sea:

Length of pipeline system: **870 Miles.**

The cost estimate to build it: **$2.7 Billion.**

Energy Generated: **2.73 MWh.**

Revenue generated: **$1,434,888 per year**.

Maintenance**: $2,000,000.**

Revenue generated: **$1,434,888** per year.

Cost Estimate for Pipeline System for the Irrigation of the Farmland Northern Area of the Salton Sea:

The farmland in the Northern area of the Salton Sea is approximately 50% of the farmland Southern Area of the Salton Sea. Here values are divided by 2. This area does not have enough drop to generate hydropower.

Length of pipeline system: **435 Miles.**

The cost estimate to build the pipeline system: **$1,378,080,000.**

Maintenance: **$1,000,000.**

Preliminary Cost/Revenue Estimate – Spreadsheet

(Harnessing Energy and Water in The Salton Sea)

(Segment II)

Description	**Cost**	**Power**	**Revenue**
Route #1 (Pipeline – San Felipe – Salton Sea)	$1.710,720,000	27.3 MWh.	$14,348,880 per year
Maintenance - Route #1			-$2,000,000.
Route #2 (Pipeline – Long Beach – Salton Sea)	$2,566,080,000	-142.1 MWh	-$74,687,760
Purchase of the **Right of Way** for **Route #2**	$500,000,000		
Maintenance - Route #2			-$2,000,000
Cost Estimate for the pipeline system **for the irrigation** for farmland **Southern** of the Salton Sea:	$2,756,160,000	2.73 MWh.	$1,434,888 per year.
Maintenance for Southern of the Salton Sea:			-$2,000,000.
Cost Estimate for the pipeline system **for irrigation** for farmland **Northern** of the Salton Sea:	$1,378,080,000.		$0
Maintenance for Northern of the Salton Sea:			-$1,000,000.

Σ	$8,911,040,000	-112.07 MWh	-$65,903,992

5. Illustrations of the Segment (II) - Importing Seawater from the Ocean for the Restoration of the Salton Sea and for Harnessing Geothermal Energy.

Segment (II)

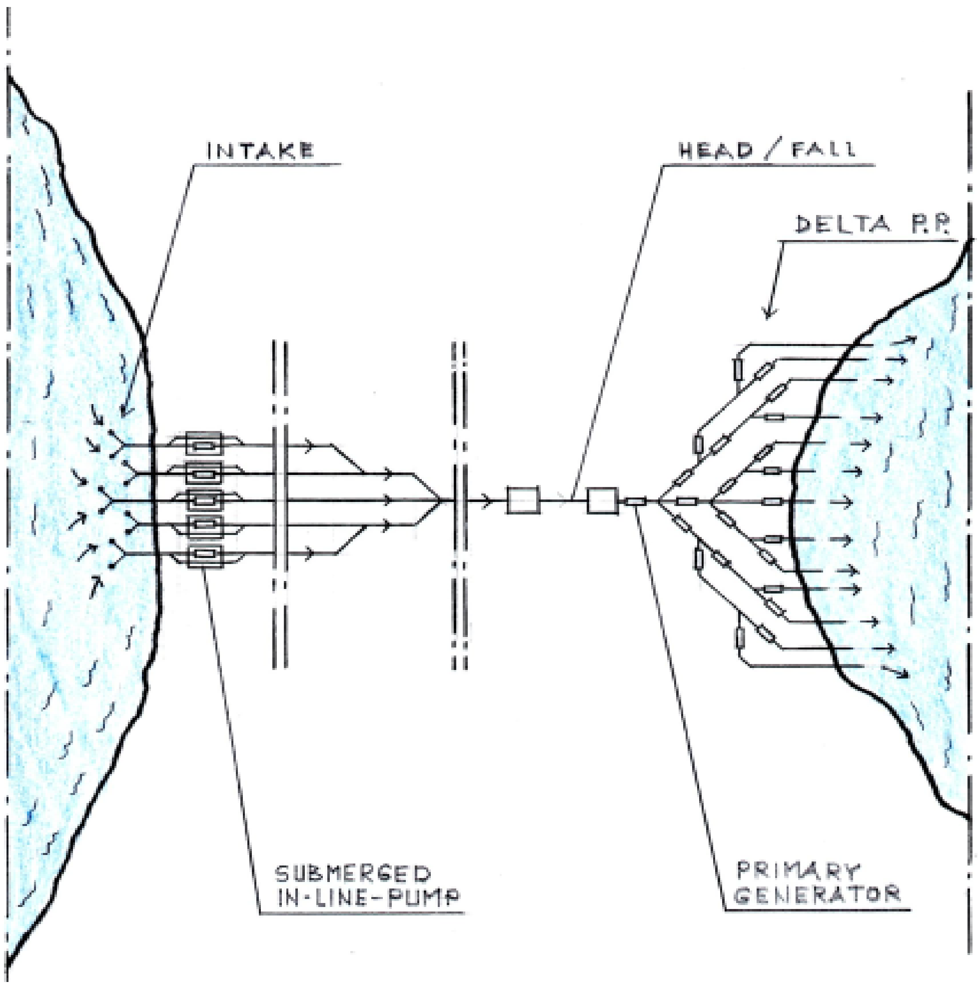


FIG. 1 – Plain View of several segments of the Route #1

Segment (II)

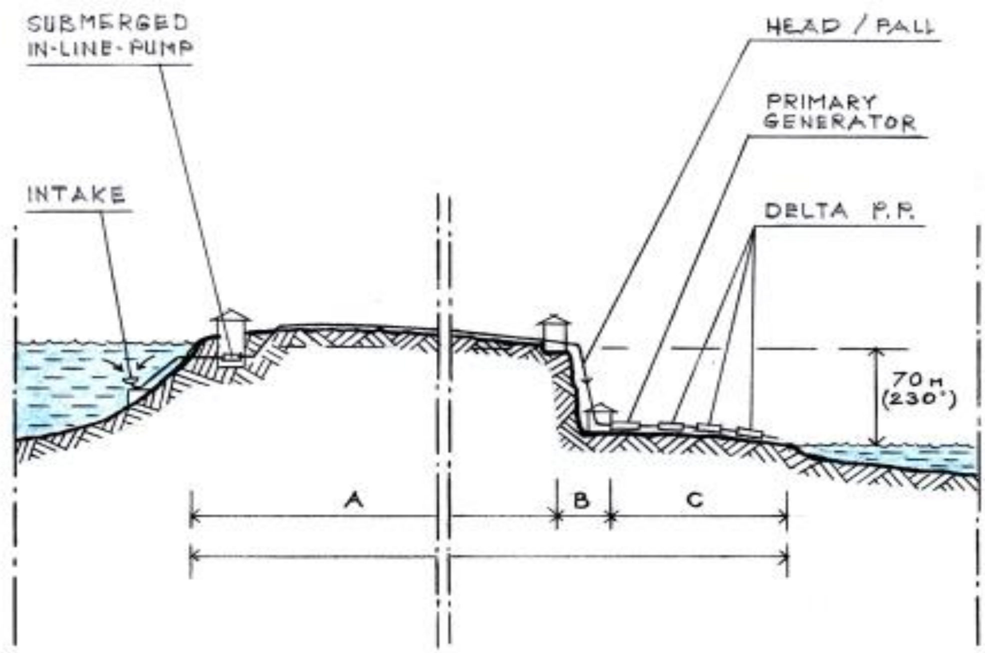


FIG. 2 – **Cross-sectional View of the Route #1**

Segment (II)

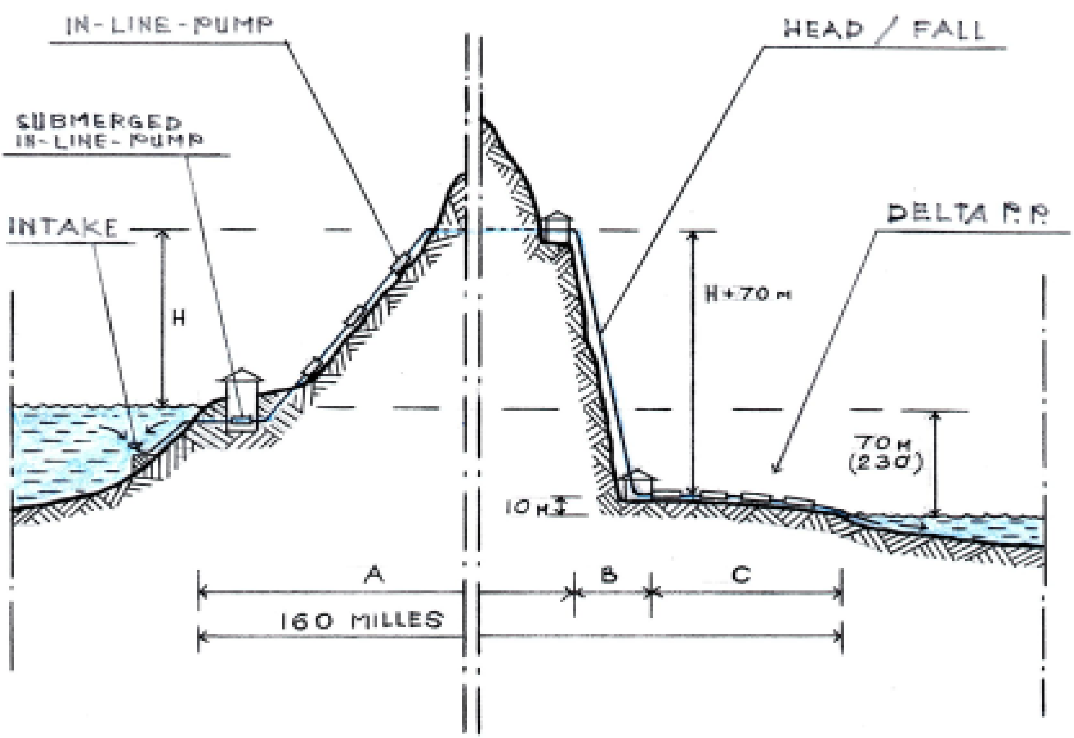


FIG. 3 – Cross-sectional View of Elevations of the Ocean and Salton Sea

Segment (II)

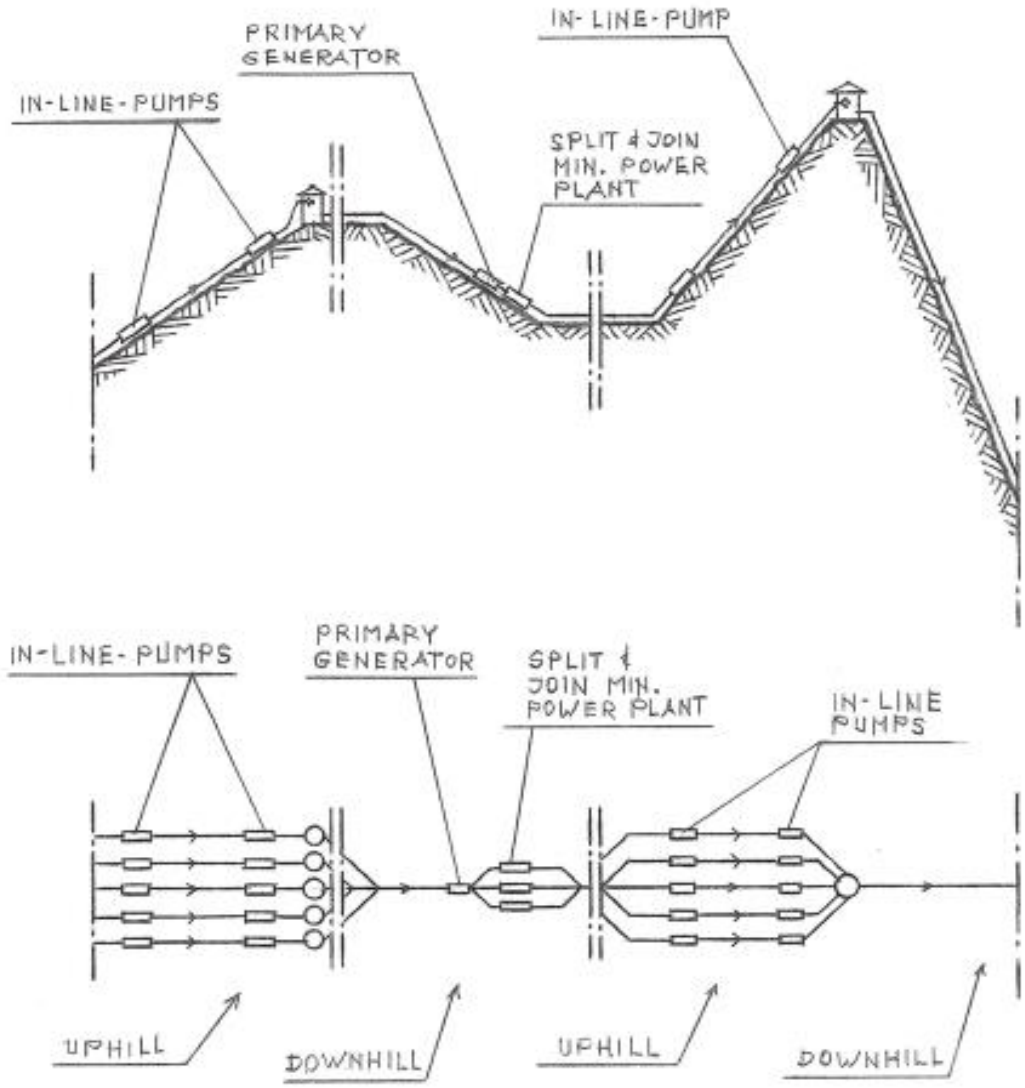
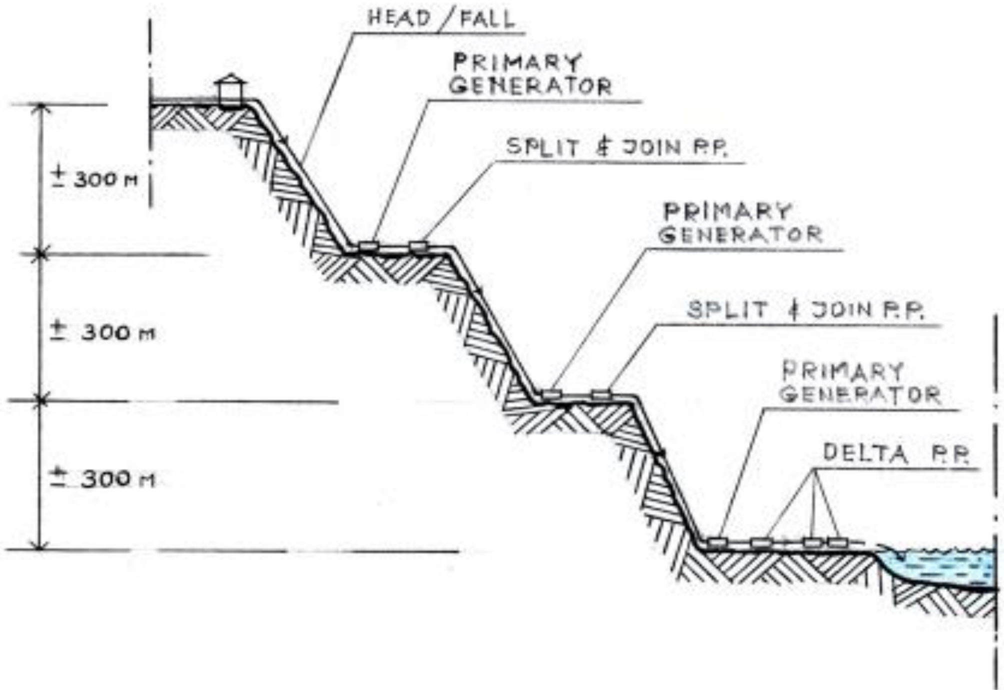


FIG. 4 – Plain and Cross-sectional View of the Mid-section of the Pipeline

Segment (II)



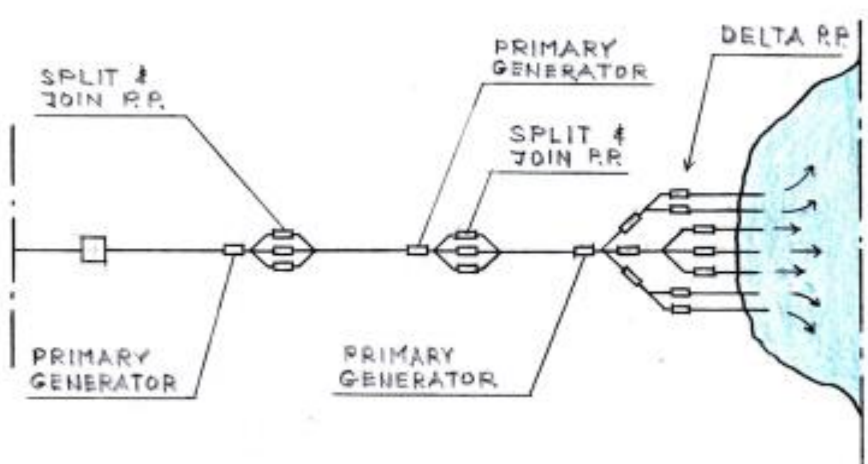


FIG. 5 – Plain and Cross-sectional View of the final downhill route

Segment (II)

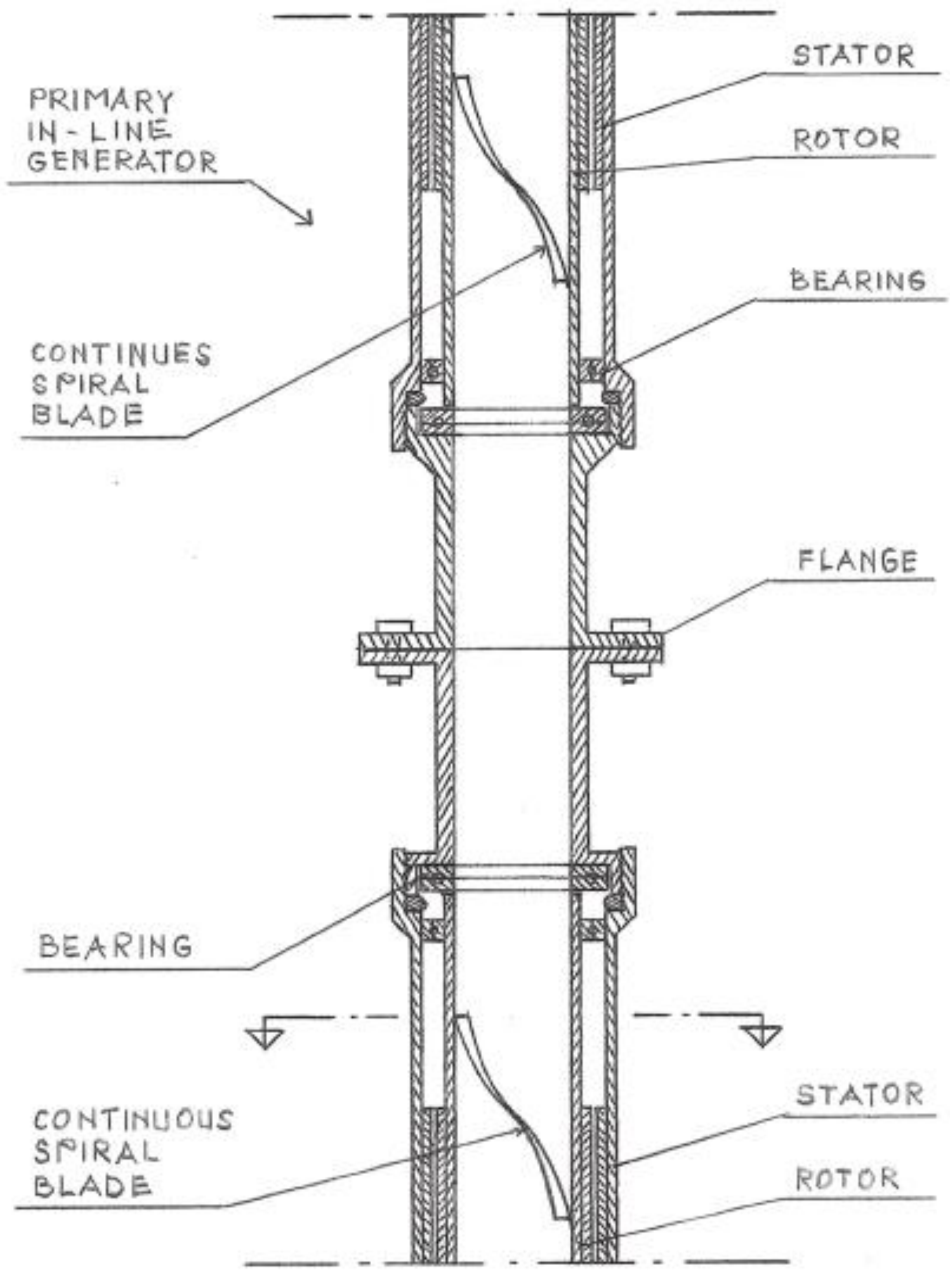


FIG. 6 – Cross-sectional longitudinal View of the Primary In-Line-Pump / Generator

Segment (II)

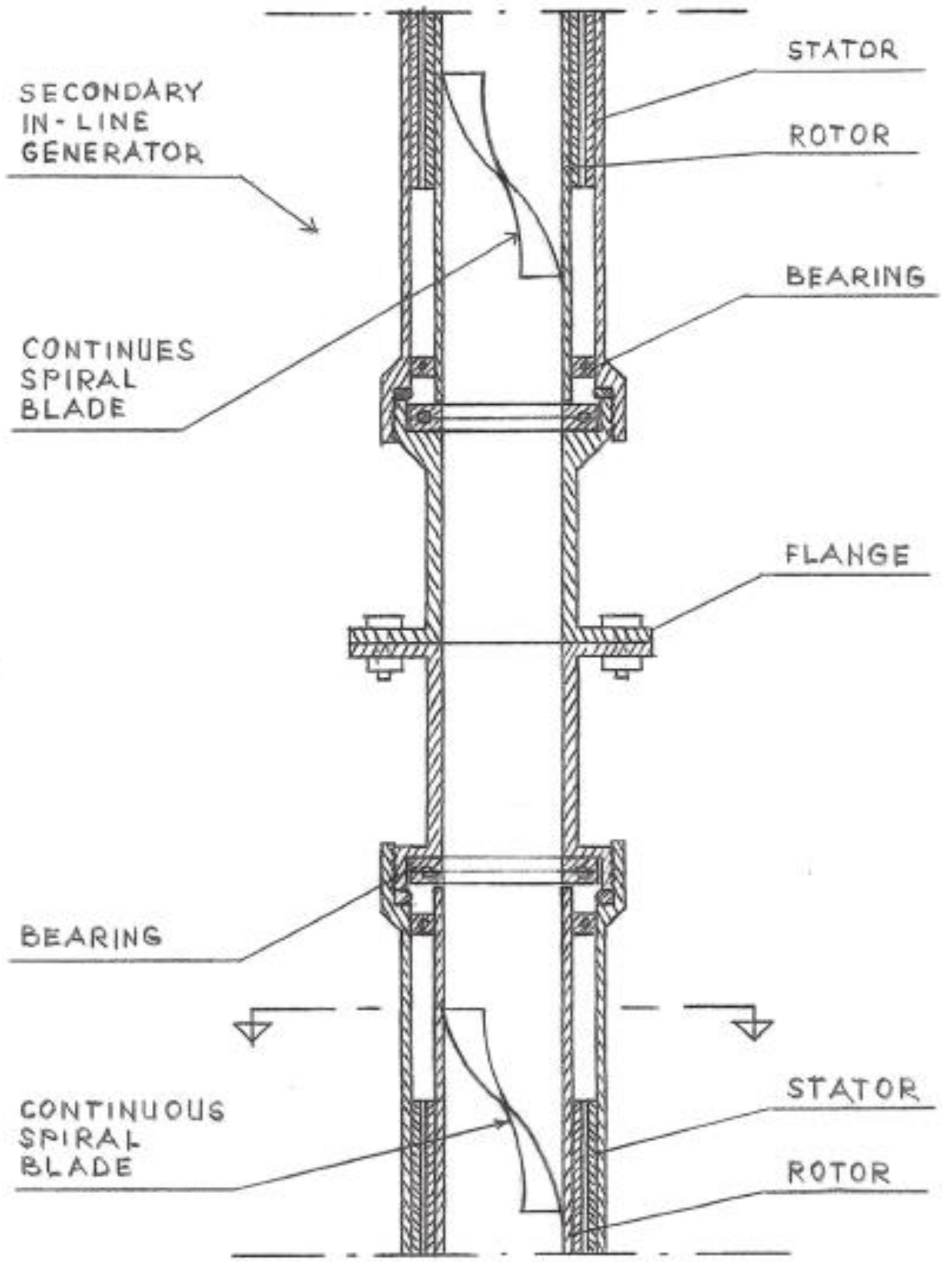


FIG. 7 – Cross-sectional longitudinal View of the Secondary In-Line-Pump / Generator

Segment (II)

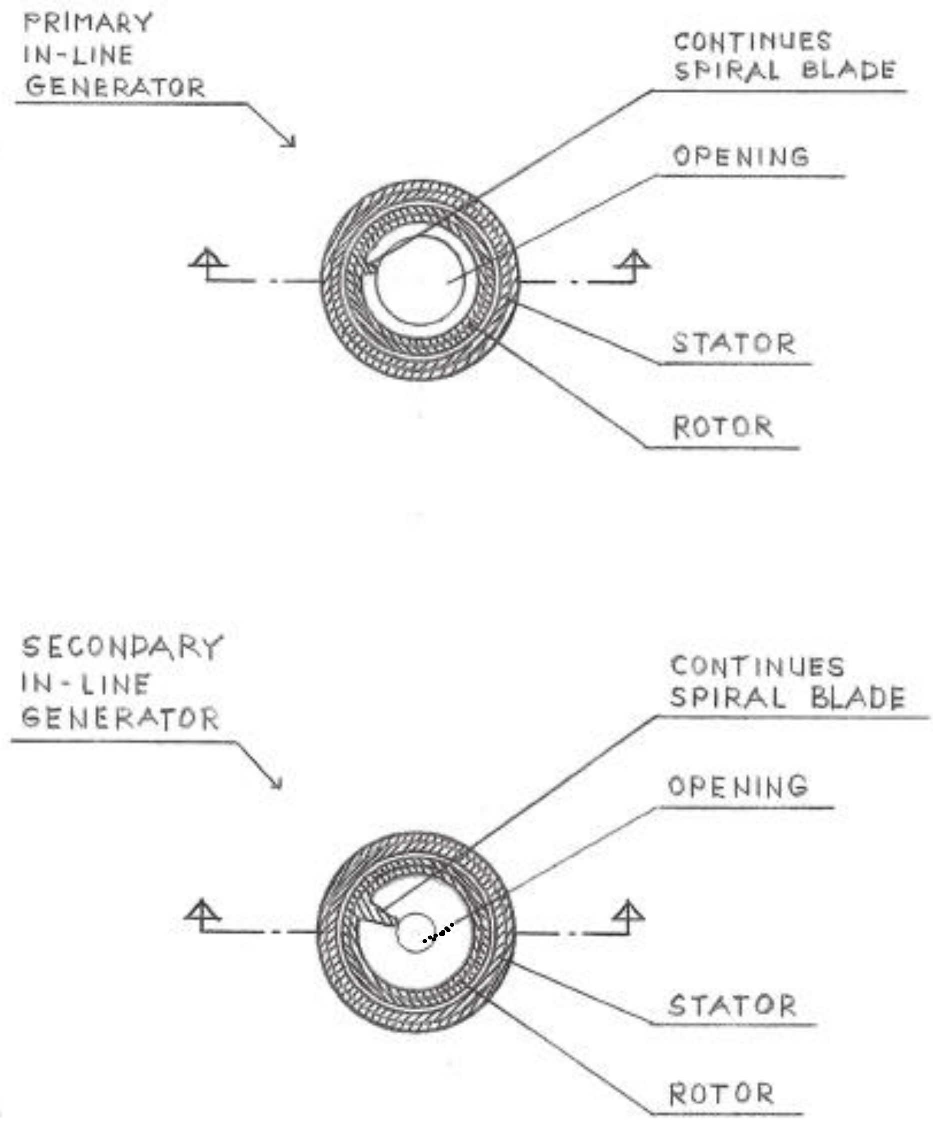


FIG. 8 – Cross-sectional Frontal View of the Primary and Secondary In-Line-Pump / Generator

FIG. 9 – Google Map of Pipelines Route # 1 from San Felipe, and Route # 2 from Long Beach to the Salton Sea.

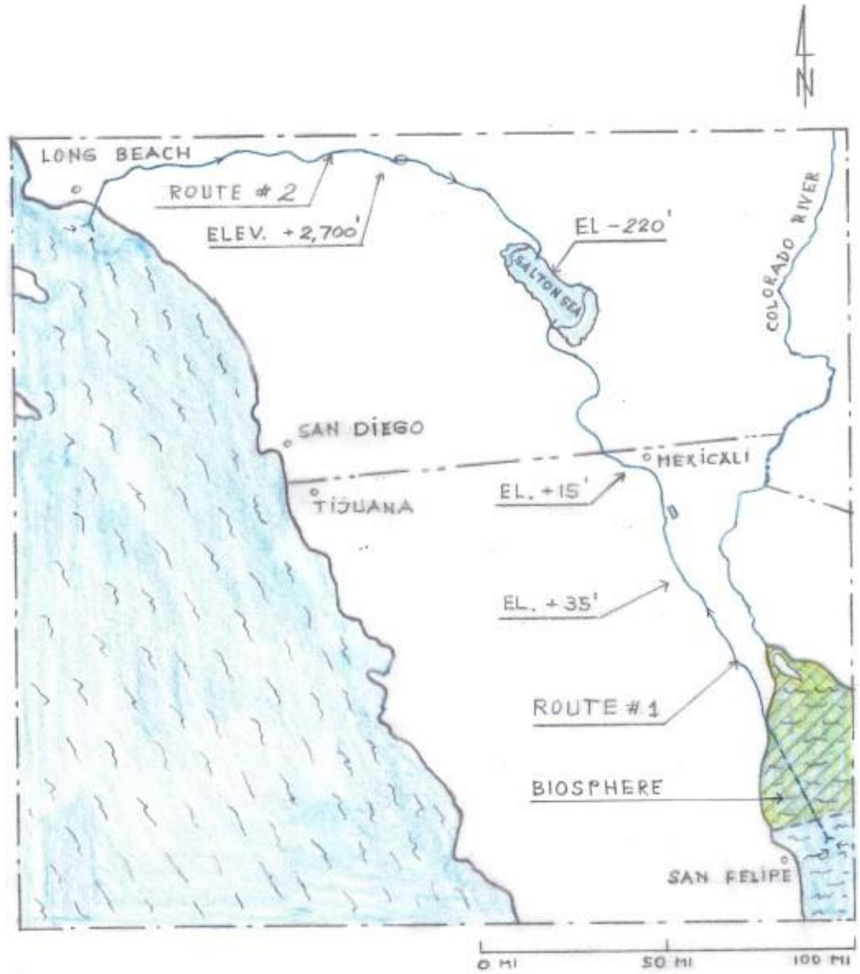


FIG. 10 - Map of Pipelines Route # 1 from San Felipe, and Route # 2 from Long Beach to the Salton Sea.

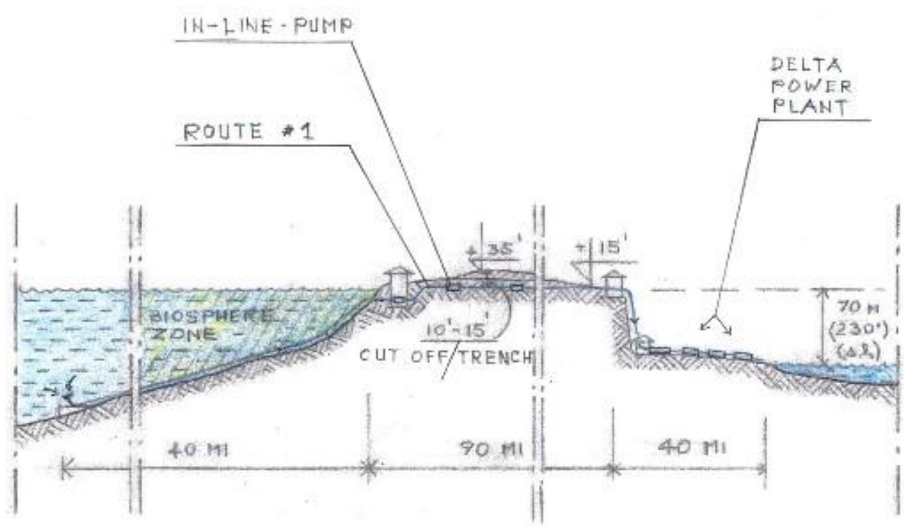


FIG. 11 – Cross-Sectional view of Pipeline Route #1

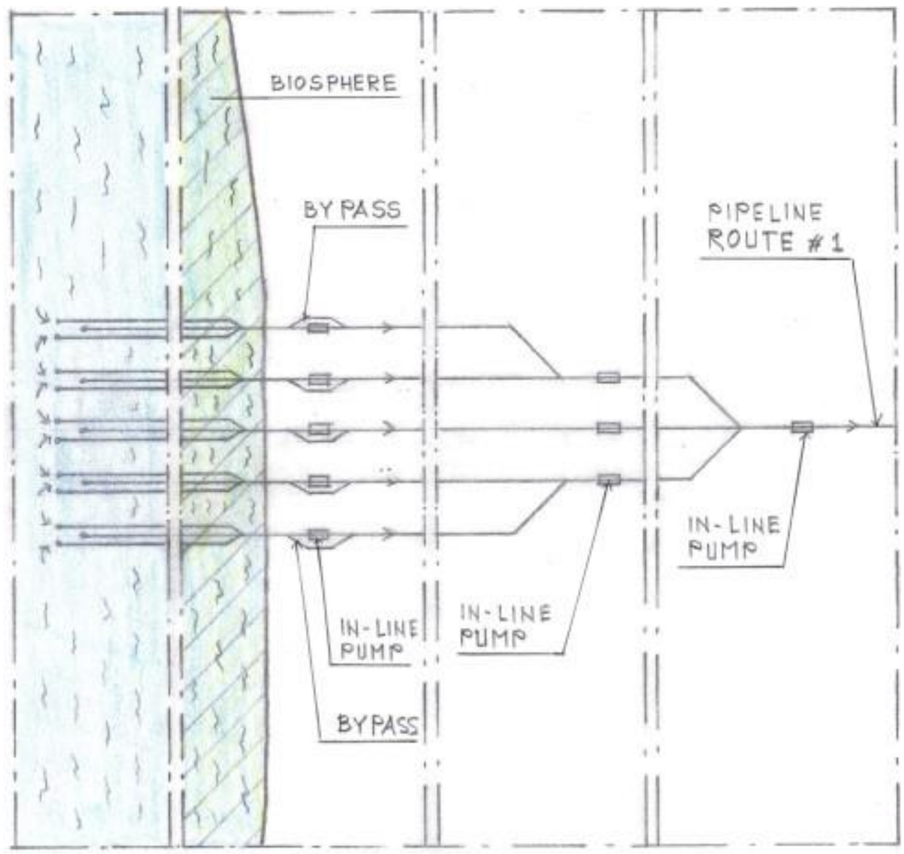


FIG. 12 – **Cross-Sectional view of the first segment of Pipeline Route #1**

3. Conclusion:

Importing seawater is a fundamental phase of the presented comprehensive proposal on which other phases depend. This segment also explains the function of necessary elements of the project and provides a rough cost estimate and potential revenue of the project proving its feasibility of the project.

Harnessing hydropower in downhill routes during the process of importing seawater is a fundamental value that makes the phase of importing seawater feasible on which other phases of this comprehensive project depend. Importing seawater is an essential element in providing the necessary water for harnessing geothermal energy in the area and is an essential element for the restoration of the Salton Sea.

A presented pipeline with a diameter of only 48" through Route #1 can import about 1 million acre-feet of seawater per year which is enough for the balancing evaporation of the Lake. The pipeline through Route #2 can import about 2 million acre-feet of seawater per year meaning that 1 million acre-feet can be used for other purposes including replenishing geothermal reservoirs.

Acknowledgment

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