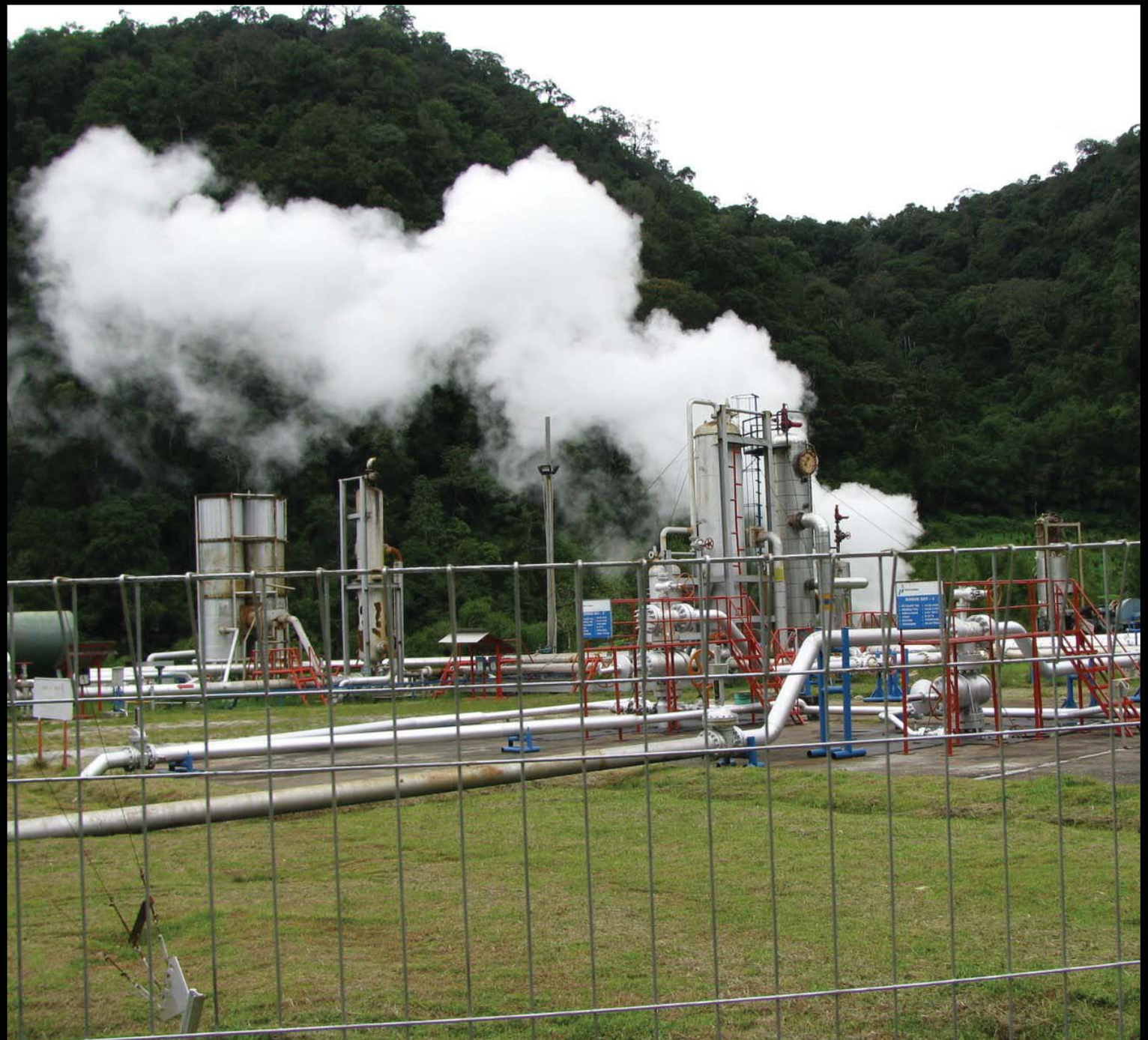
GEOTHERMAL SPA

An attempt to connect social, economic, and environmental solutions for Samosir region in North Sumatra, Indonesia

LEONIE MONIAGA Climate Adaptation Lab P4 PRESENTATION 18/03/10


HEAT UNDERGROUND = CONVERTED TO ELECTRICITY



ADVANTAGES OF GEOTHERMAL ENERGY

SUPPLY
ABBUNDANT SUPPLY

LAND USE
LOW AMOUNT OF LAND REQUIRED

POLLUTION
REDUCE EMMISIONS IN THE ATMO-SPHERE

RELIABILITY
24 HOURS AVAILABLE

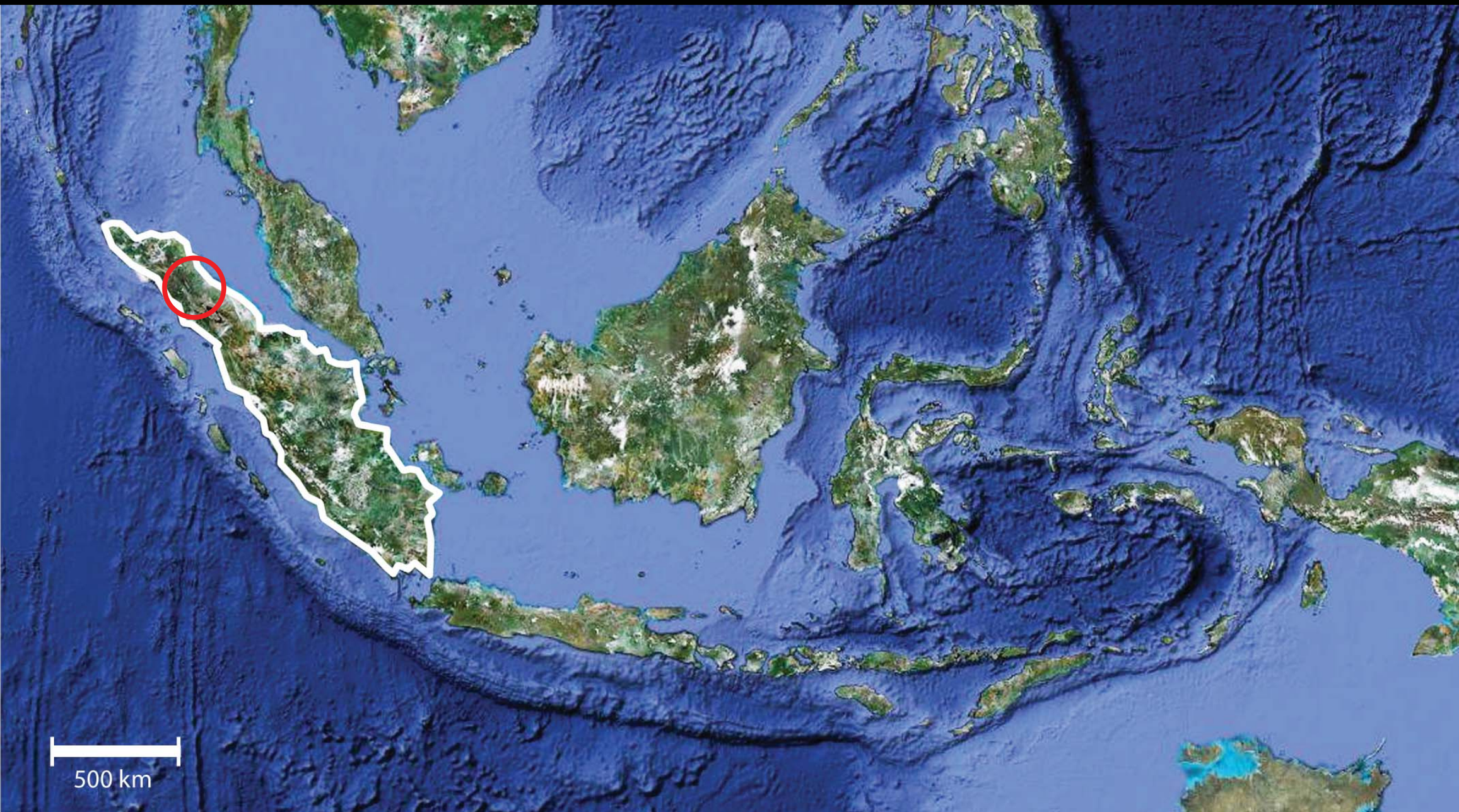
COST
NO FUEL COST
LOW MAINTENANCE

COMPARISON WITH OTHER RENEWABLE ENERGY

TABLE 7. STATUS OF RENEWABLE ENERGY TECHNOLOGIES, END 2001

Technology	Increase in energy production, 1997–2001 (percent per year)	Operating capacity, end 2001	Capacity factor (percent)	Energy production, 2001	Turnkey investment costs (2001 US$ per kilowatt)	Current energy cost	Potential future energy cost
Biomass energy							
Electricity	~ 2.5	~ 40 GWe	25–80	~ 170 TWh (e)	500–6000	3–12 ¢/kWh	4–10 ¢/kWh
Heat[a]	~ 2	~ 210 GWth	25–80	~ 730 TWh (th)	170–1000	1–6 ¢/kWh	1–5 ¢/kWh
Ethanol	~ 2	~ 18 bln litres		~ 450 PJ		(8–25 $/GJ	(6–10 $/GJ
Bio-diesel	~ 1	~ 1.2 bln litres		~ 45 PJ		15-25 $/GJ)	10-15 $/GJ)
Wind electricity	~ 30	23 GWe	20–40	43 TWh (e)	850–1700	4–8 ¢/kWh	3–10 ¢/kWh
Solar photovoltaic electricity	~ 30	1.1 GWe	6–20	1 TWh (e)	5000–18000	25–160 ¢/kWh	5 or 6–25 ¢/kWh
Solar thermal electricity	~ 2	0.4 GWe	20 – 35	0.9 TWh (e)	2500–6000	12–34 ¢/kWh	4–20 ¢/kWh
Low-temperature solar heat	~ 10	57 GWth (95 million m^2)	8–20	57 TWh (th)	300–1700	2–25 ¢/kWh	2–10 ¢/kWh
Hydro energy							
Large	~ 2	690 GWe	35–60	2600 TWh (e)	1000–3500	2–10 ¢/kWh	2–10 ¢/kWh
Small	~ 3	25 GWe	20–90	100 TWh (e)	700–8000	2–12 ¢/kWh	2–10 ¢/kWh
Geothermal energy							
Electricity	~ 3	8 GWe	45–90	53 TWh (e)	800–3000	2–10 ¢/kWh	1 or 2–8 ¢/kW
Heat	~ 10	11 GWth	20–70	55 TWh (th)	200–2000	0.5–5 ¢/kWh	0.5–5 ¢/kWh
Marine energy							
Tidal	0	0.3 GWe	20–30	0.6 TWh (e)	1700–2500	8–15 ¢/kWh	8–15 ¢/kWh
Wave	–	exp. phase	20–35	0	2000–5000	10–30 ¢/kWh	5–10 ¢/kWh
Tidal stream/Current	–	exp. phase	25–40	0	2000–5000	10–25 ¢/kWh	4–10 ¢/kWh
OTEC	–	exp. phase	70–80	0	8000–20000	15–40 ¢/kWh	7–20 ¢/kWh

LOCATION
INDONESIA



INDONESIA is located in the area "ring of fire"
surrounded by vulcanic mountains geothermal energy is a big opportunity

NL / 2,5 KM/ 70-80 degree Celcius
IND/ 500 m / 100-120 degree Celcius

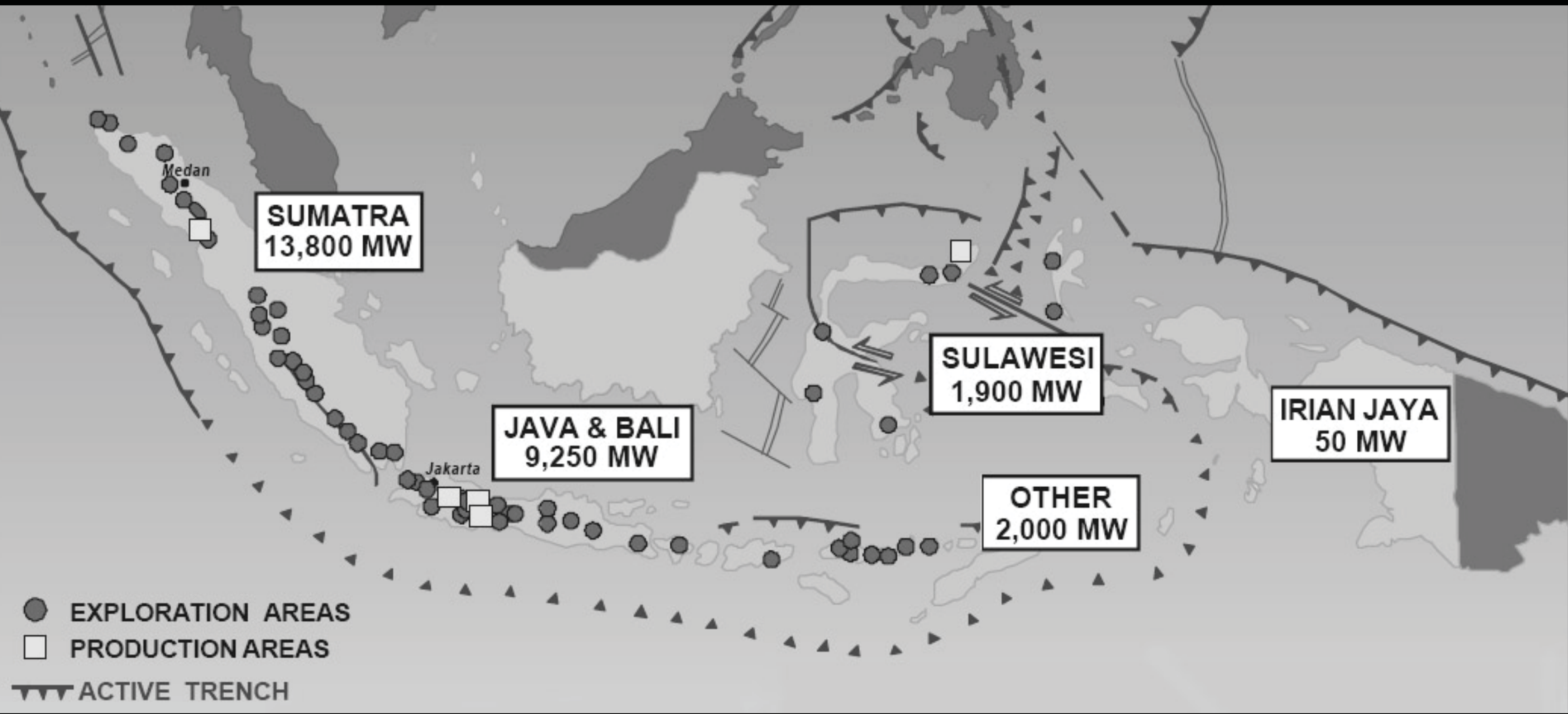
INSTALLED GEOTHERMAL CAPACITY
WORLDWIDE

Installed Geothermal capacity ~8.500 MW, Worldwide potential ~60.000 MW

Country	Potential for electricity generation	Installed capacity
	MW	TOTAL MW
South & Central America	3.500	1.220
The Philippines	6.000	1.900
Africa, inclusive Kenya	6.500	60
Indonesia	27.000	790
P.R China	6.700	30
USA	12.000	2.300
New Zealand	1.200	450
Japan	2.400	550
Europe, inclusive Iceland and Azores islands	2.000	1.050
Russia	1.400	60

SOURCE
WORLD GEOTHERMAL ASSOCIATION

INDONESIAN GEOTHERMAL POTENTIAL



LOCATION CHOSEN : SUMATRA
13.800 MW RESOURCES FROM THE 27.000 MW

SOURCE:
Indonesian Geothermal Association

LOCATION

SAMOSIR, NORTH SUMATRA

PROBLEMS ON LOCATION SAMOSIR, NORTH SUMATRA

Environmental, Economic, and Social problems affecting the living quality of the inhabitants

PROBLEM STATEMENT

ENVIRONMENTAL ISSUES ARE STILL COMPETING WITH PUBLIC HEALTH AND SOCIAL ISSUES

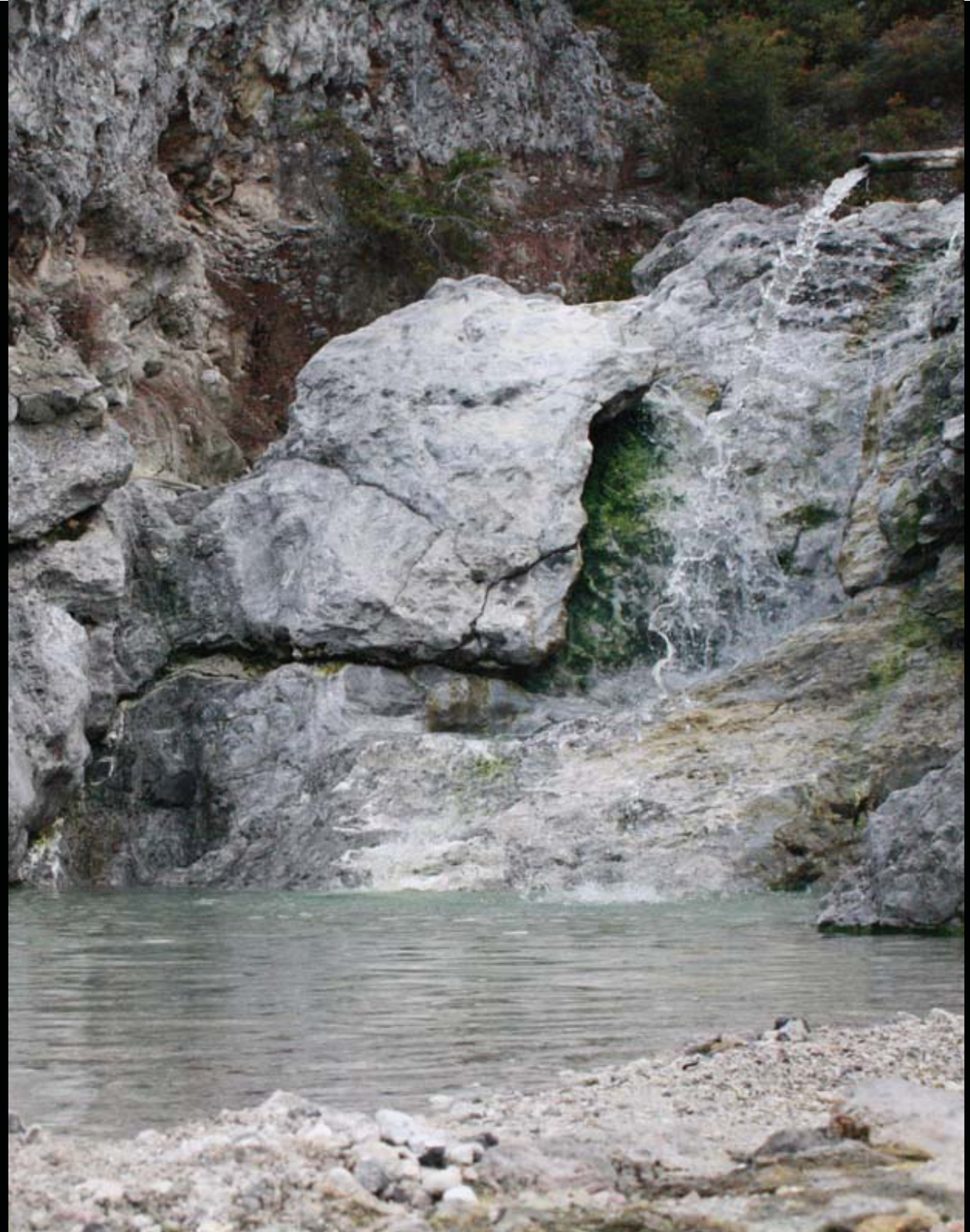
- Lack of education and knowledge 67,4% 0-30 years (Big potential for the future)
- Lack of awareness of disposal of domestic waste 47- 58% dominant source of the water pollution
- Lack of electricity 8 hours/day no electricity

PROBLEM APPROACH

STARTING WITH PROVIDING ECONOMY, SOCIAL, AND CLEAN ENVIRONMENT

- Attracting more tourist to the area to provide extra income
- Providing work fields
- Providing electricity
- Giving onsite educations
- Introducing clean energy and clean environment

USING ARCHITECTURE AS A TOOL .....



WHY SPA?

GEOTHERMAL WATER
BALNEOLOGY

ADVANTAGES
The hot water produced by the earth contains minerals that can be use to cure a lot of diseases

BALNEOTHERAPY
It may involve hot or cold water, massage through moving water, relaxation or stimulation. Many mineral waters at spas are rich in particular minerals (silica, sulfur, selenium, radium) which can be absorbed through the skin

EXAMPLES
Diabetes
Rheumatism
Skin diseases
Therapy for stroke patients (depending on the minerals

ELECTRICITY

SIBAYAK GEOTHERMAL POWER PLANT, NORTH SUMATRA

The only producing geothermal field in North Sumatra with 10 MW capacity

Producing 5.952.000 kWh in August 2009

= 8.000.000 W

Capacity factor = 80 %

Target on producing 61.752.000 kWh for 2009

EXCEL ANALYSIS

ELECTRICITY SAMOSIR, NORTH SUMATRA

Energy needs of The
Toba Samosir Region

Classified in

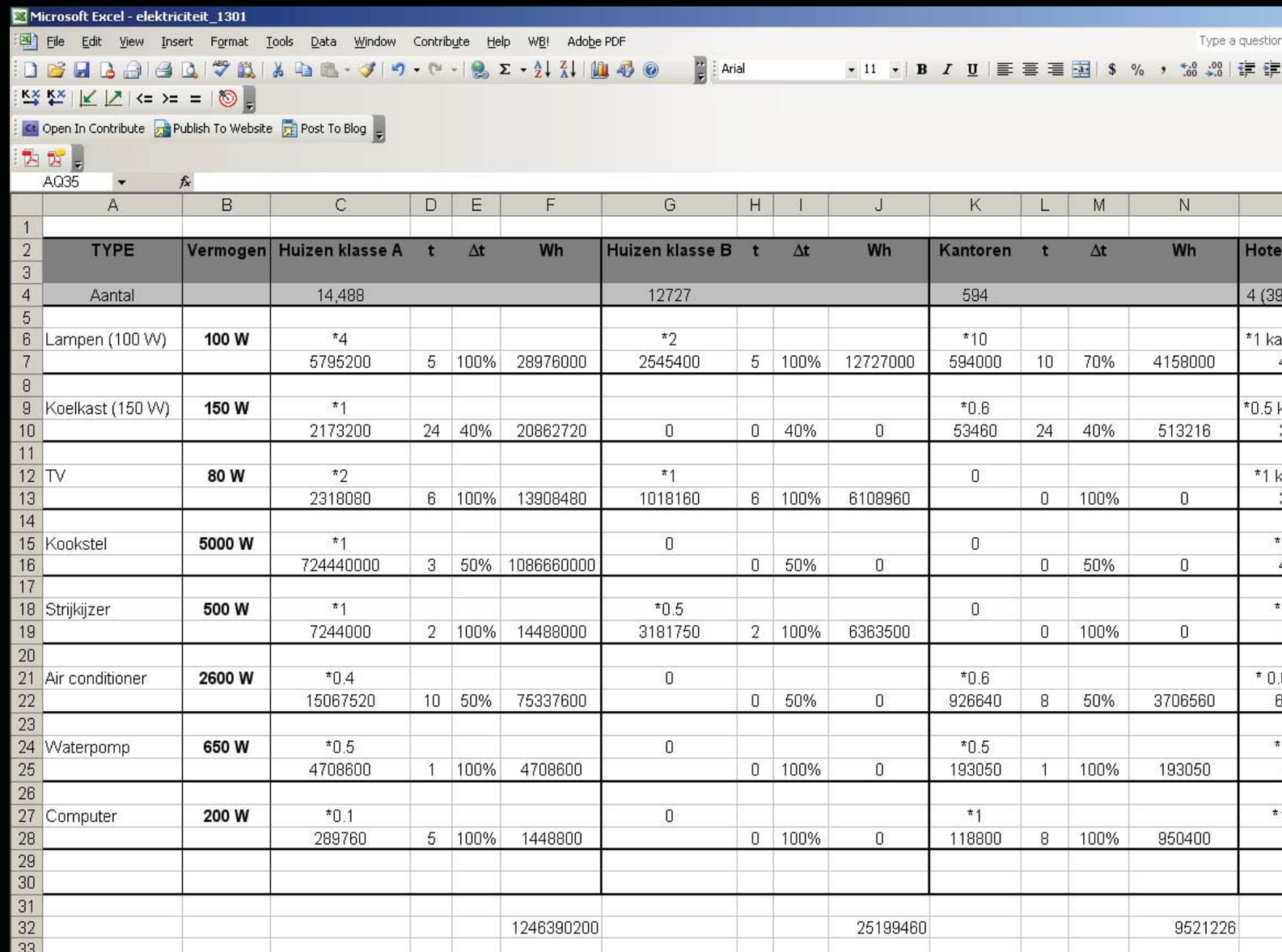
-Households type,
-Public services
(hospital and hotels)
-Private offices

Energy needs for the region
39.898.757,39 kwH/month

= 53.627362,083 W

Compared to Sibayak
80 % capacity factor

Capacity power plant
needed 67.5 MW



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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1															
2	**TYPE**	**Vermogen**	**Huizen klasse A**	**t**	**Δt**	**Wh**	**Huizen klasse B**	**t**	**Δt**	**Wh**	**Kantoren**	**t**	**Δt**	**Wh**	**Hote**
3															
4	Aantal		14,488				12727				594				4 (39
5															
6	Lampen (100 W)	**100 W**	*4				*2				*10				*1 ka
7			5795200	5	100%	28976000	2545400	5	100%	12727000	594000	10	70%	4158000	
8															
9	Koelkast (150 W)	**150 W**	*1								*0.6				*0.5 k
10			2173200	24	40%	20862720	0	0	40%	0	53460	24	40%	513216	
11															
12	TV	**80 W**	*2				*1				0				*1 k
13			2318080	6	100%	13908480	1018160	6	100%	6108960		0	100%	0	
14															
15	Kookstel	**5000 W**	*1				0				0				*
16			724440000	3	50%	1086660000		0	50%	0		0	50%	0	
17															
18	Strijkijzer	**500 W**	*1				*0.5				0				*
19			7244000	2	100%	14488000	3181750	2	100%	6363500		0	100%	0	
20															
21	Air conditioner	**2600 W**	*0.4				0				*0.6				* 0.
22			15067520	10	50%	75337600		0	50%	0	926640	8	50%	3706560	6
23															
24	Waterpomp	**650 W**	*0.5				0				*0.5				*
25			4708600	1	100%	4708600		0	100%	0	193050	1	100%	193050	
26															
27	Computer	**200 W**	*0.1				0				*1				*
28			289760	5	100%	1448800		0	100%	0	118800	8	100%	950400	
29															
30															
31															
32						1246390200				25199460				9521226	
33															


A
20 km

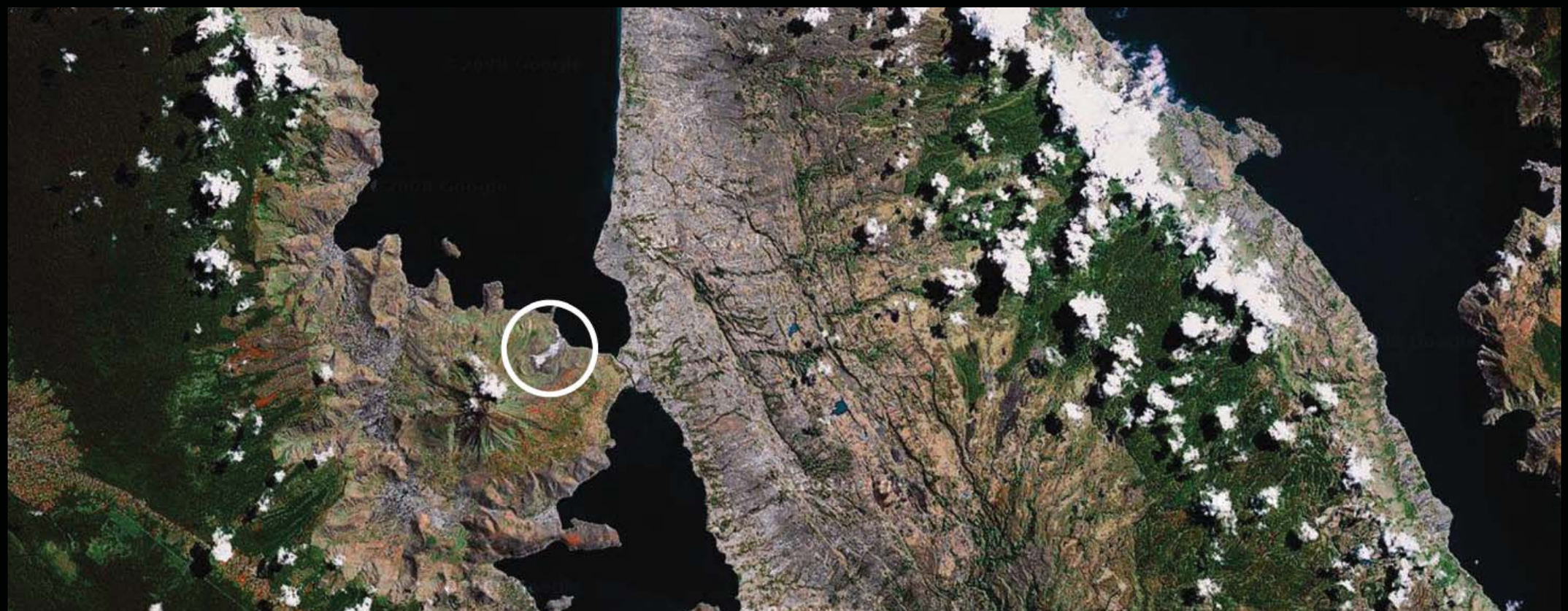
Indonesia's Geothermal Potential (MW)

Prospect Areas	Installed	Reserves		Resources	Total
		Proven	Possible		
North Sumatra					
G. sinabung				150	150
Sibayak	2	39	131	70	240
Sarulla		280		100	380
Sibualbuali			600	150	750
Sorik Merapi			250	150	400
Pusuk Buhit				250	250
Simbolon				250	250

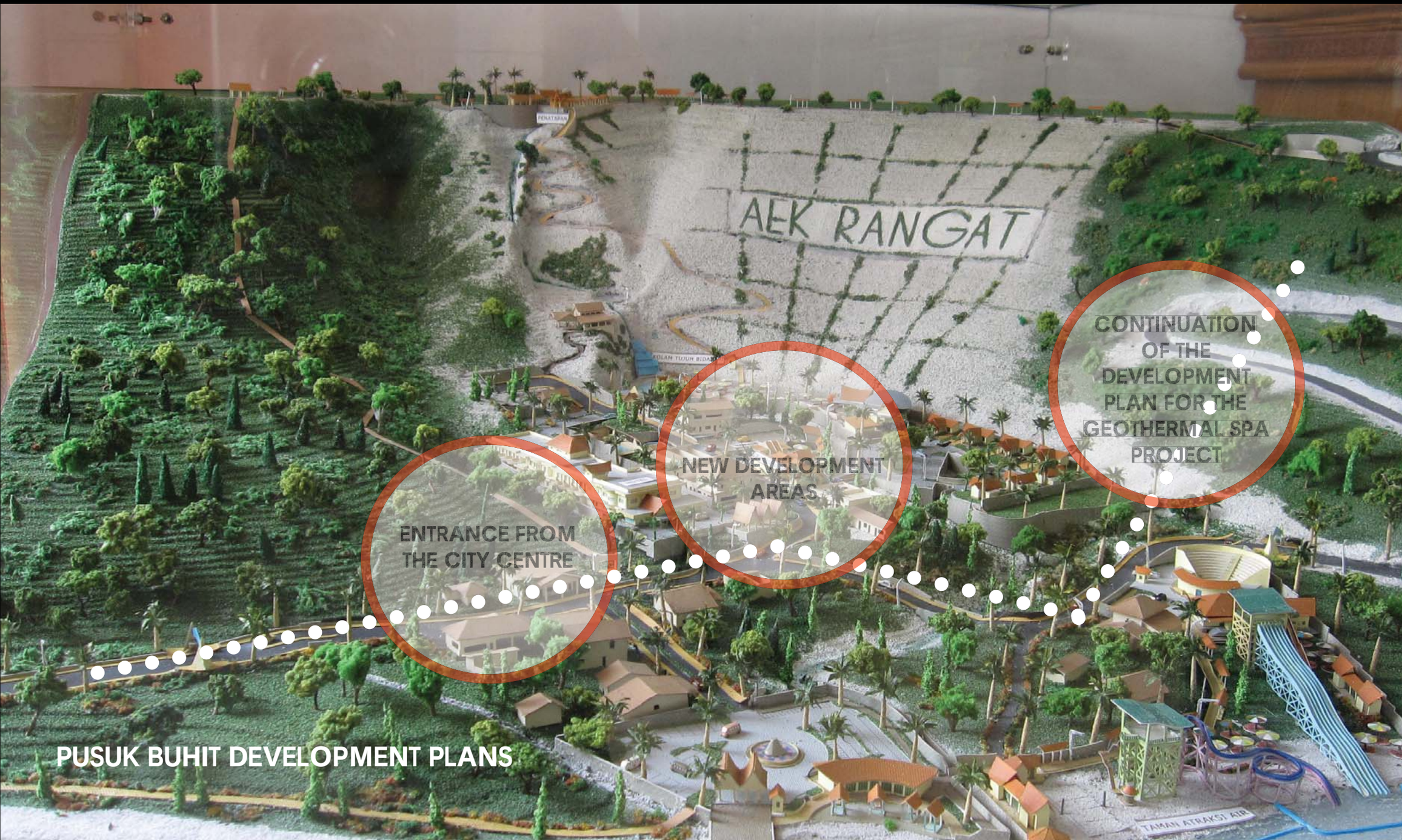
LOCATION PUSUK BUHIT
Resources 250 MW
FEASIBLE for 67,5 MW needed for the region

SOURCE:
Indonesian Geothermal Association

PUSUK BUHIT
THE LOCATION



PUSUK BUHIT VOLCANO



PUSUK BUHIT DEVELOPMENT PLANS


GREEN MOUNTAIN
STRUCTURES
THE LAKE
TOP OF THE
MOUNTAIN
WHITE MOUNTAIN
STRUCTURES
Pangururan
from panguruan

THE LOCATION

GREEN MOUNTAIN
STRUCTURES

THE LAKE

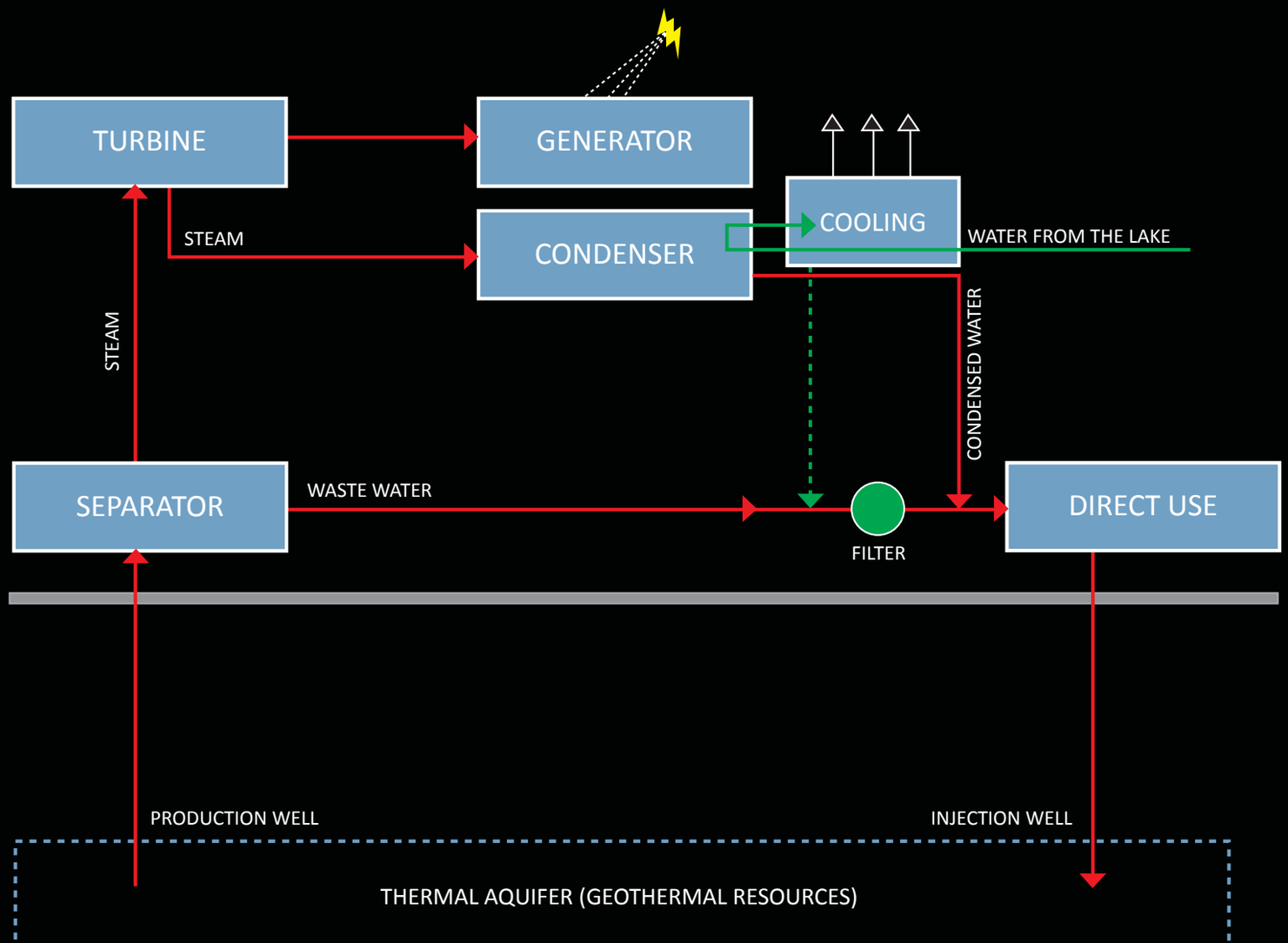
TOP OF THE
MOUNTAIN

WHITE MOUNTAIN
STRUCTURES

from pangururan

THE POTENTIAL GEOTHERMAL SYSTEM IN THE LOCATION

DERRIVED FROM THE GEOTHERMAL FLASH SYSTEM AND MODIFIED



TEMPERATURE
DIRECT USE

Applications of DIRECT USE GEOTHERMAL HEAT according to the World Geothermal Association

The applications are ordered according to different temperatures

Digestion in paper pulp; Evaporation of highly concentrated solutions

Heavy water via hydrogen sulphide process

Drying of fish meal and timber

Alumina via Bayers process

Drying farm products; Food canning

Evaporation in sugar refining; Extraction of salts by evaporation & crystallisation; Fresh water by distillation

concentration of saline solution; refrigeration (medium temperature)

Drying and curing of light aggregrate cement slabs

Drying of Organic materials eg. seaweed, grass, vegetables, etc

Washing and drying of wool

Intense de-icing operations

Space Heating (buildings+greenhouses)

Refrigeration (lower temperature limit)

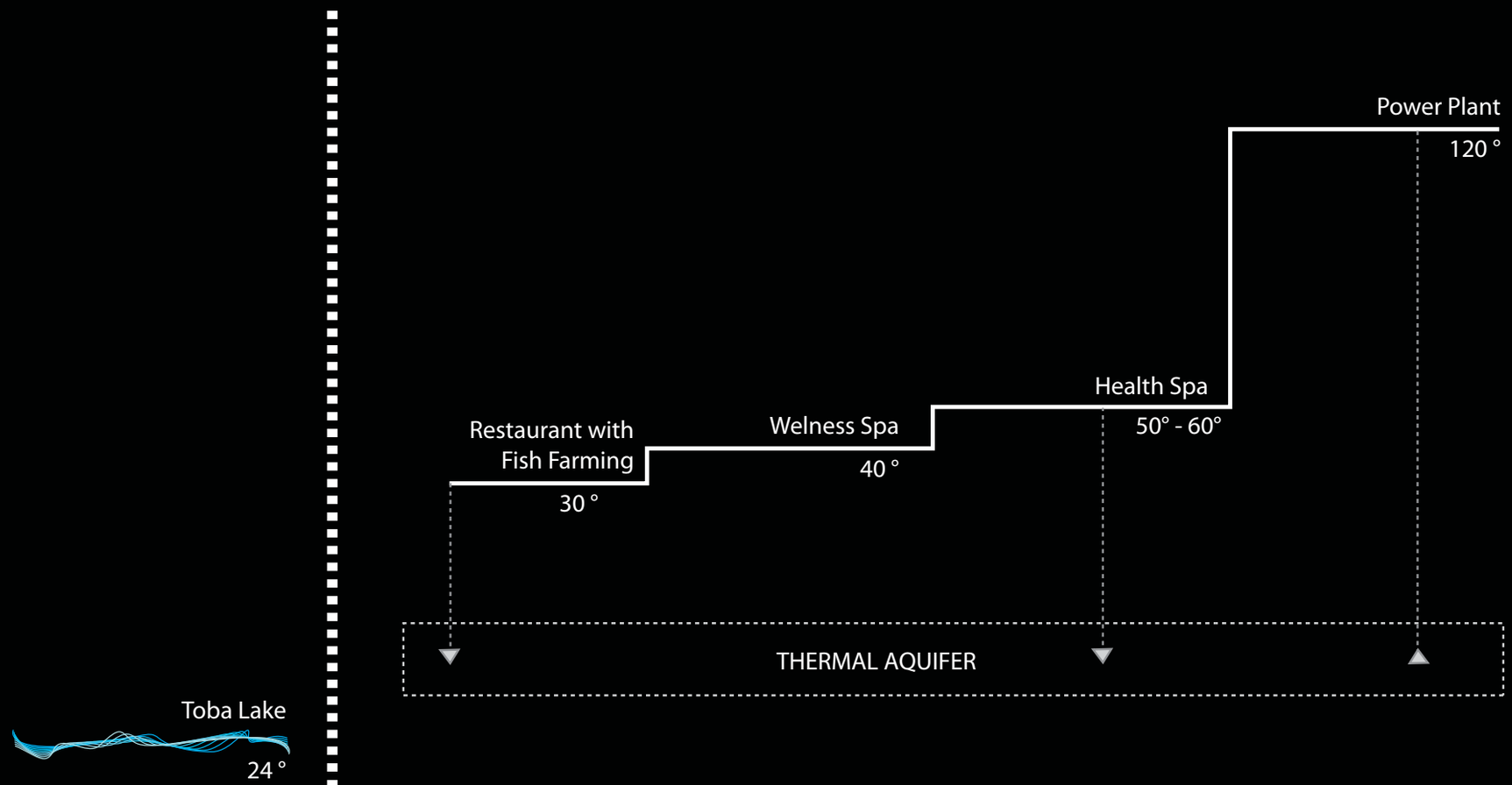
Animal husbandry and Greenhouses by combined space)

Mushroom growing; Balneology; Therapeutic Hot springs

Soil Warming; Swimming pools; Biodegradation; Fermentations

Warm water for year round mining in cold climates; De- icing; Fish farming

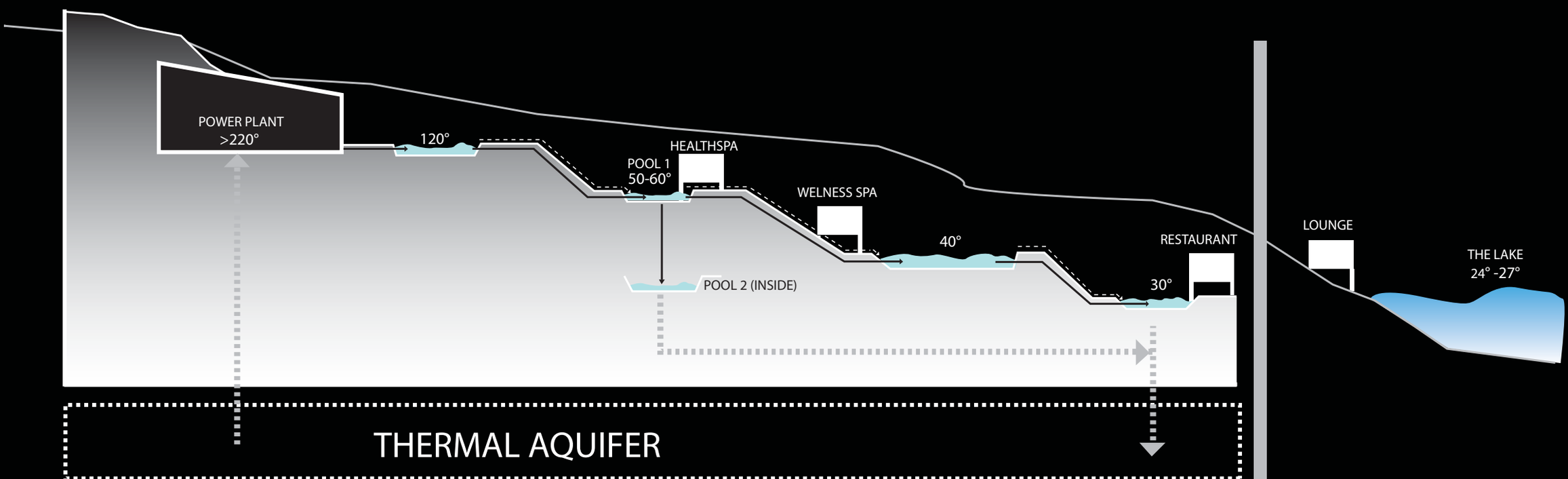
CONCEPT
TEMPERATURE FLOW



THE TEMPERATURE of THE GEOTHERMAL WATER will varies throughout the functions

DIRECT USE SYSTEM IN THE BUILDING(S)

HOT WATER

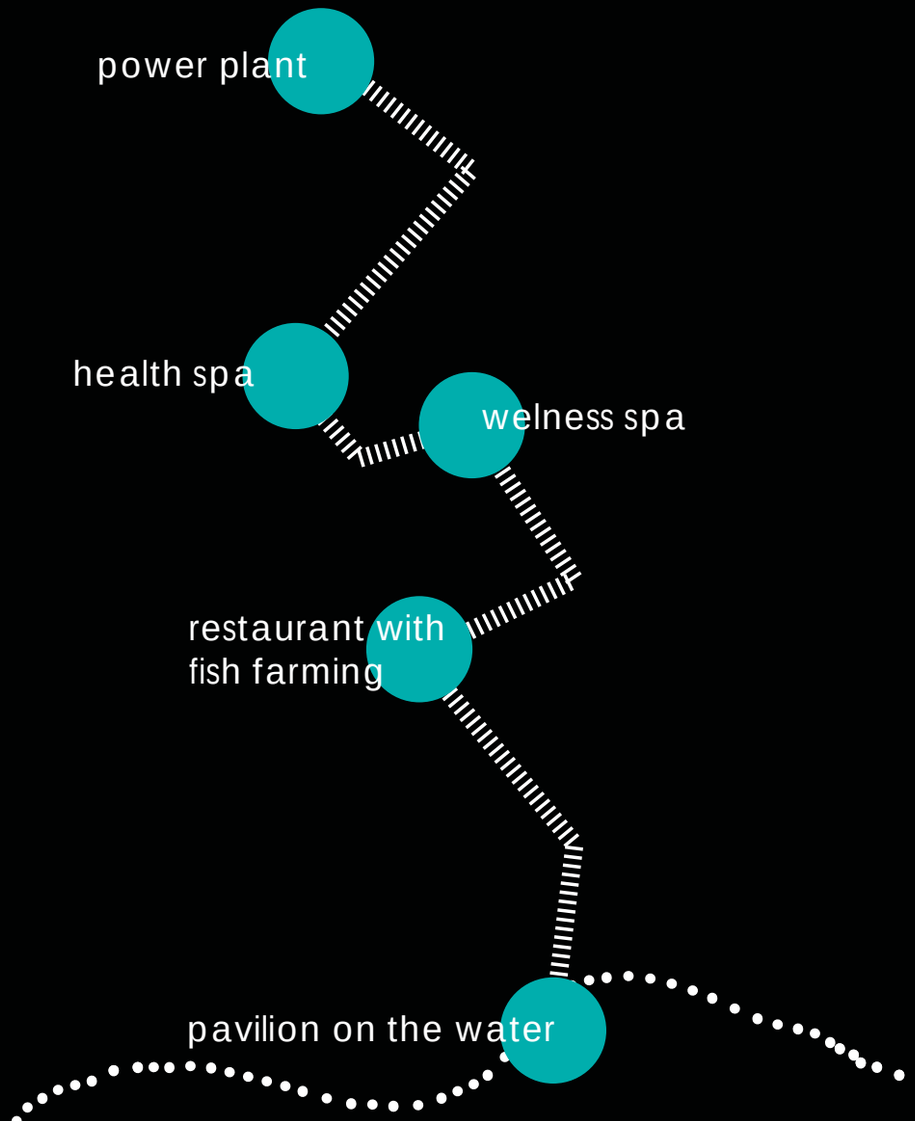


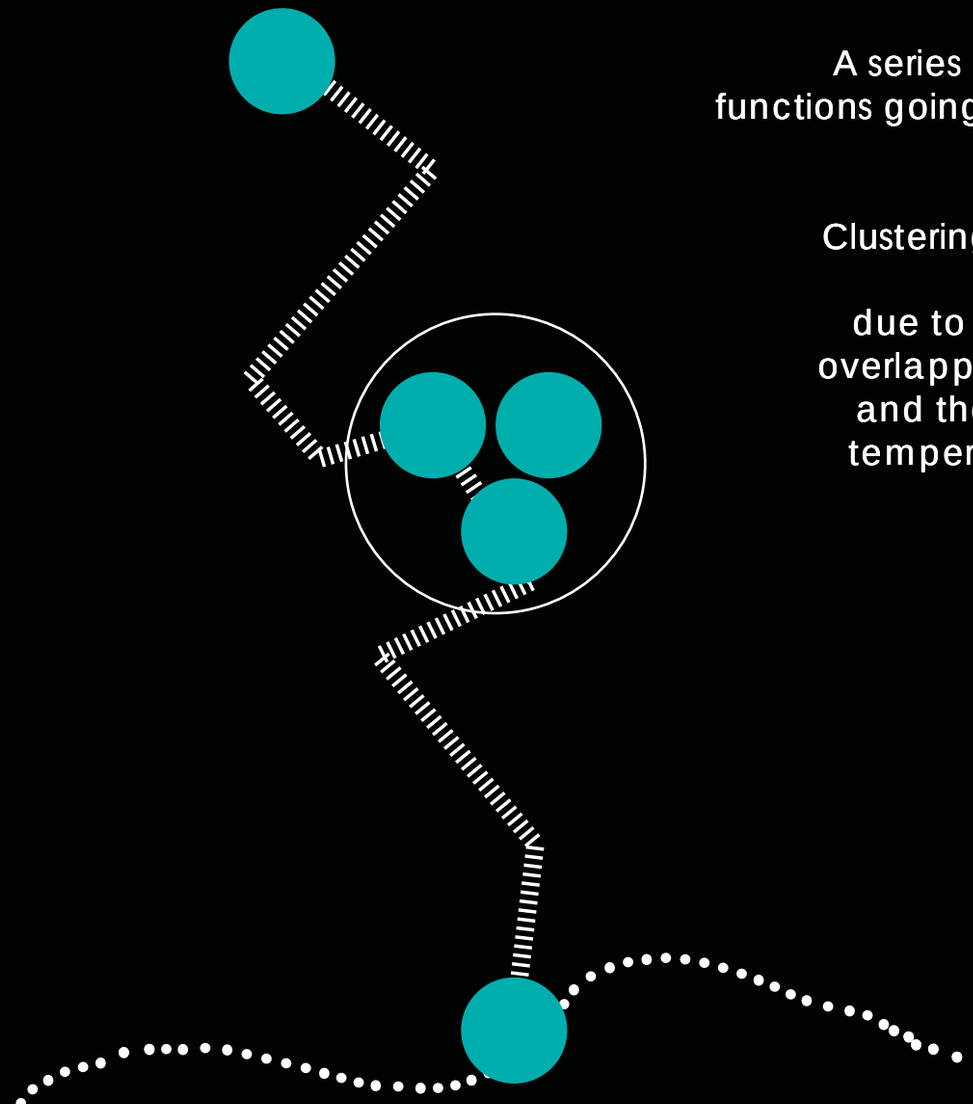
CONCEPT

ROUTE AND FUNCTIONS

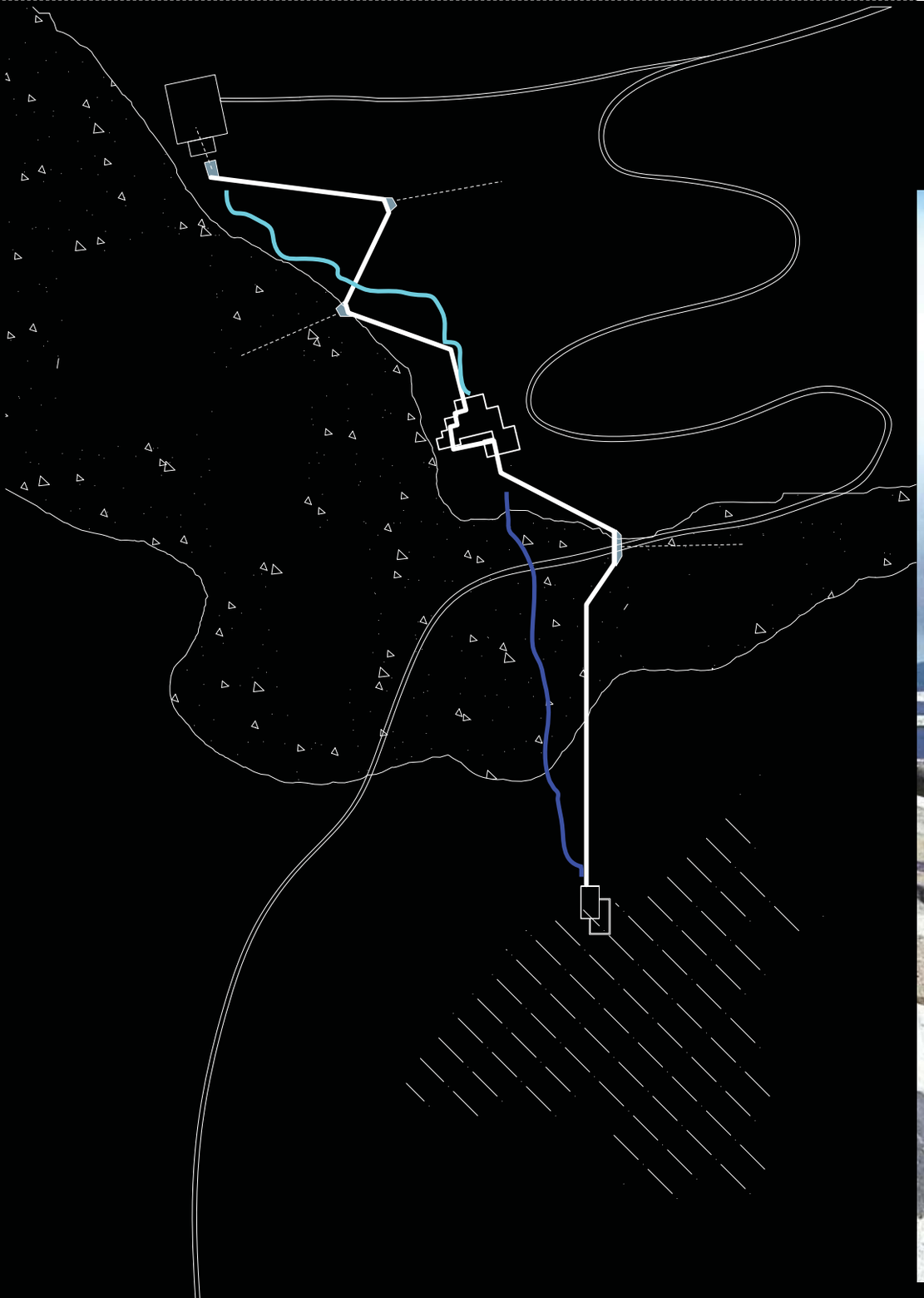
A series of different functions going along the route

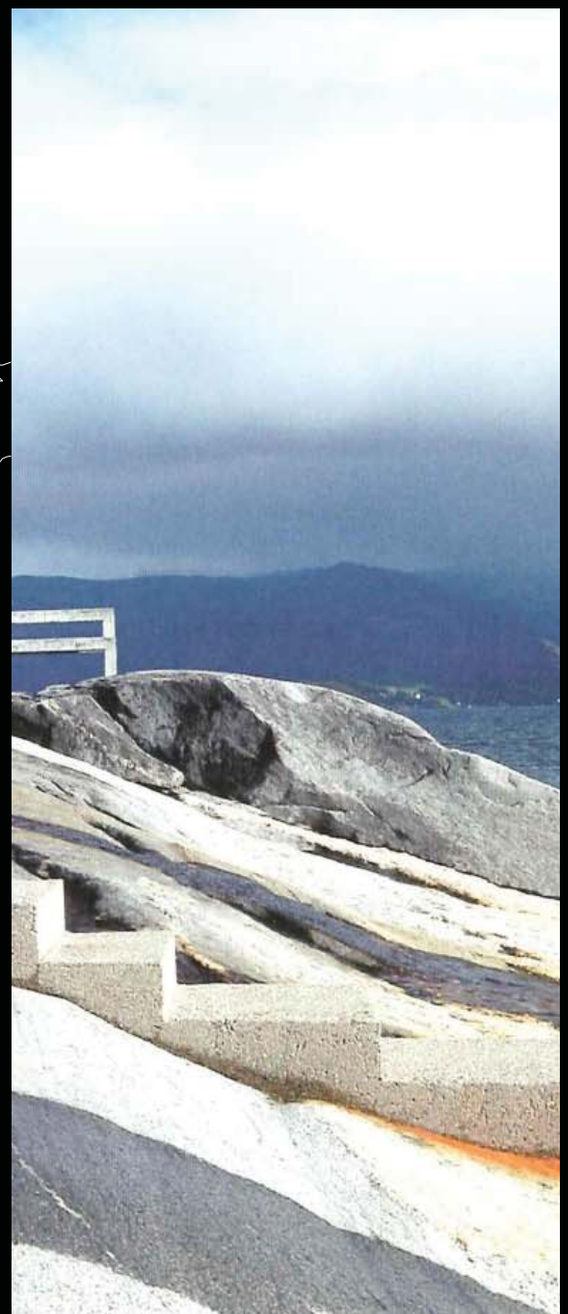
Clustering the three functions due to similar and overlapping spaces and the minimum temperature drop

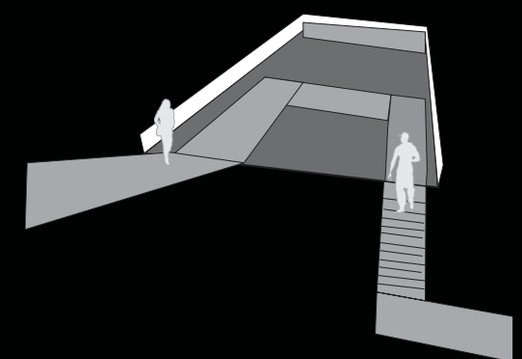


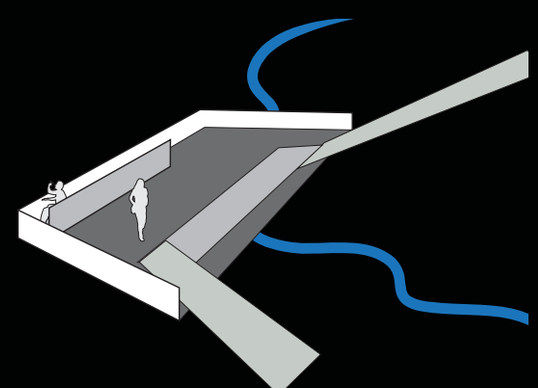


URBAN CONTEXT HOT SPRING AREA
WALKING ROUTE AND WATER FLOW



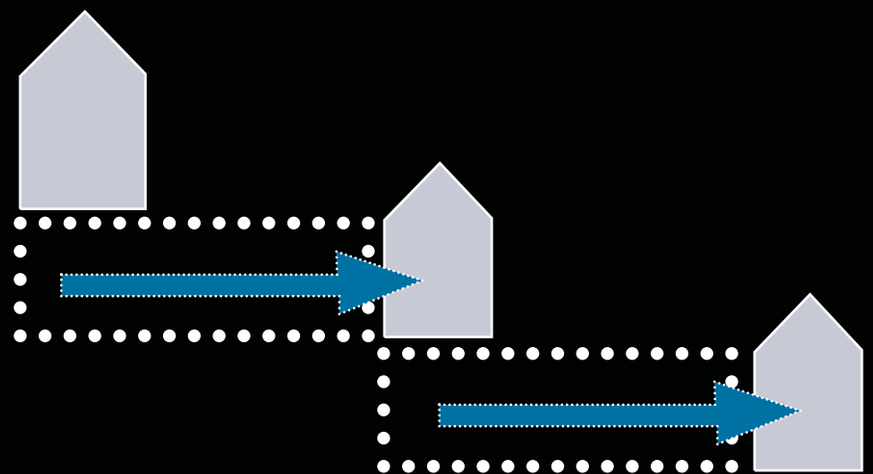




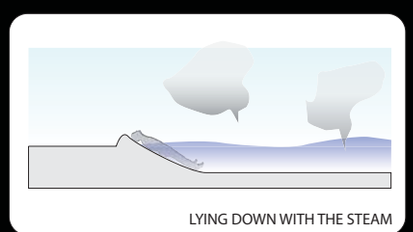


BUILDING CONCEPT

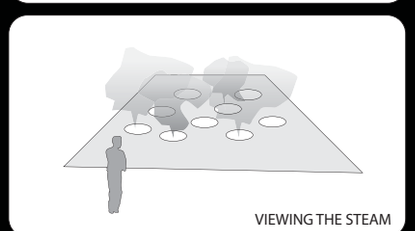
STACKINGS AND FUNCTION CONNECTIONS



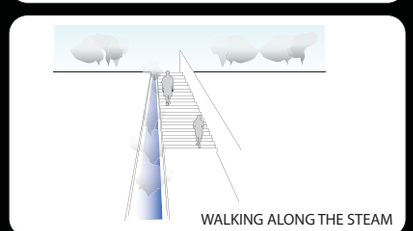
SITTING BETWEEN THE STEAM



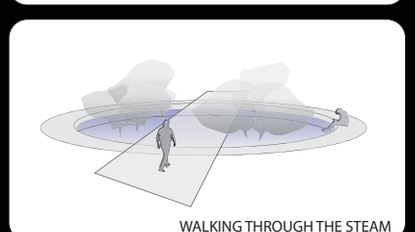
LYING DOWN WITH THE STEAM



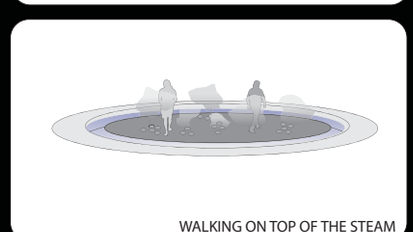
VIEWING THE STEAM



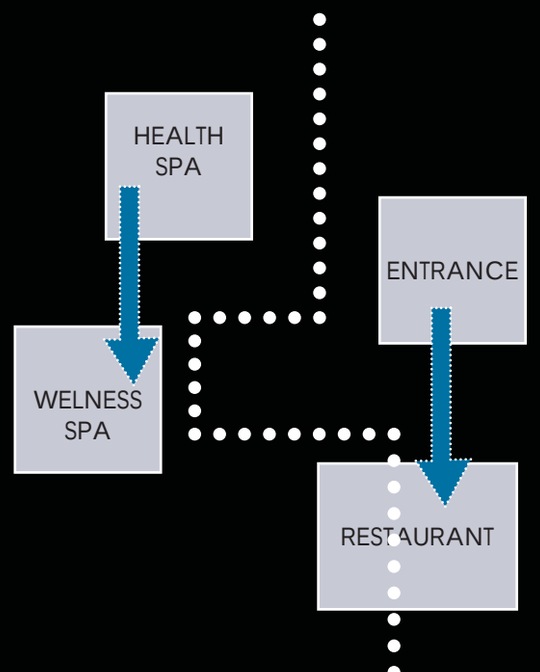
WALKING ALONG THE STEAM



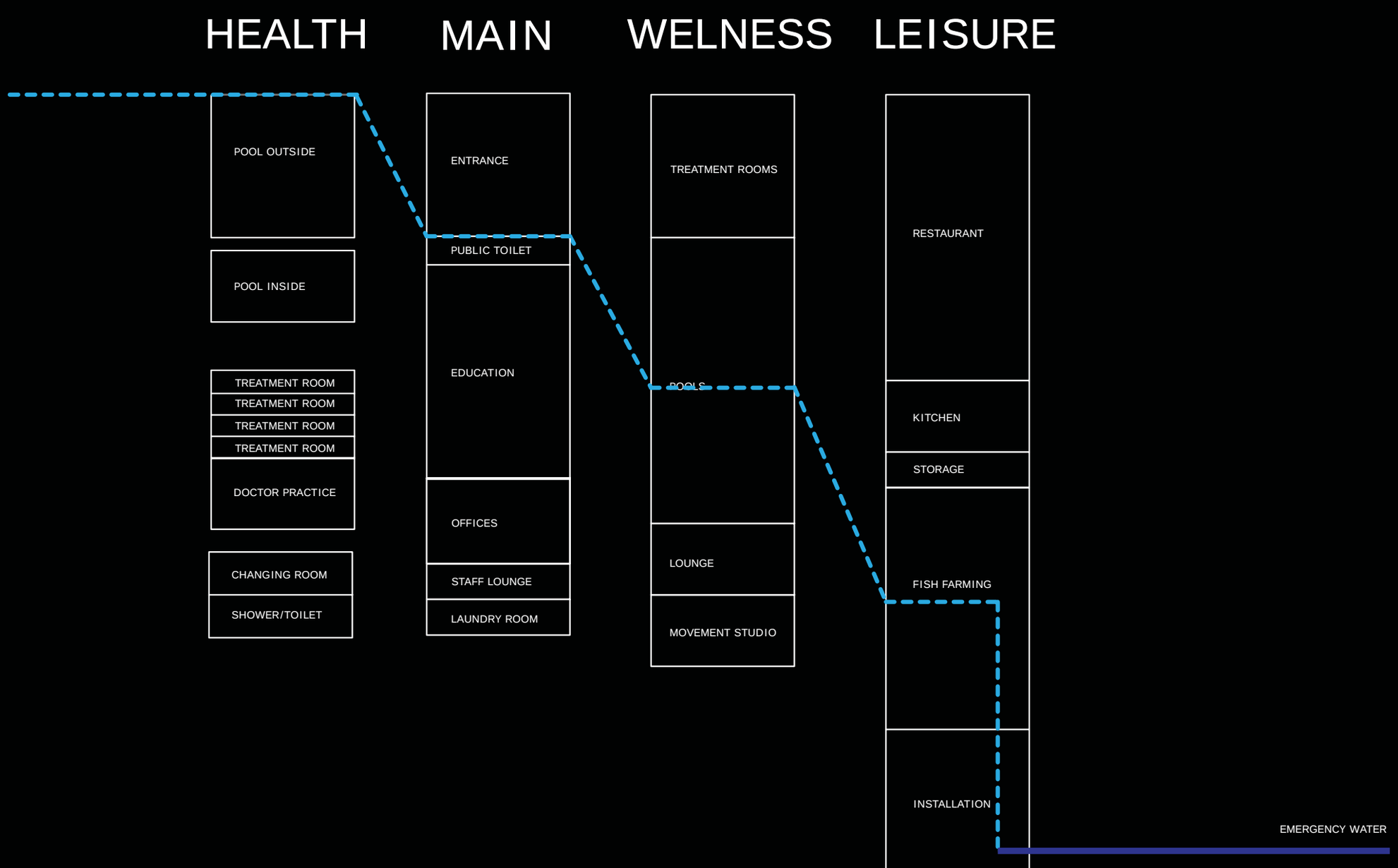
WALKING THROUGH THE STEAM



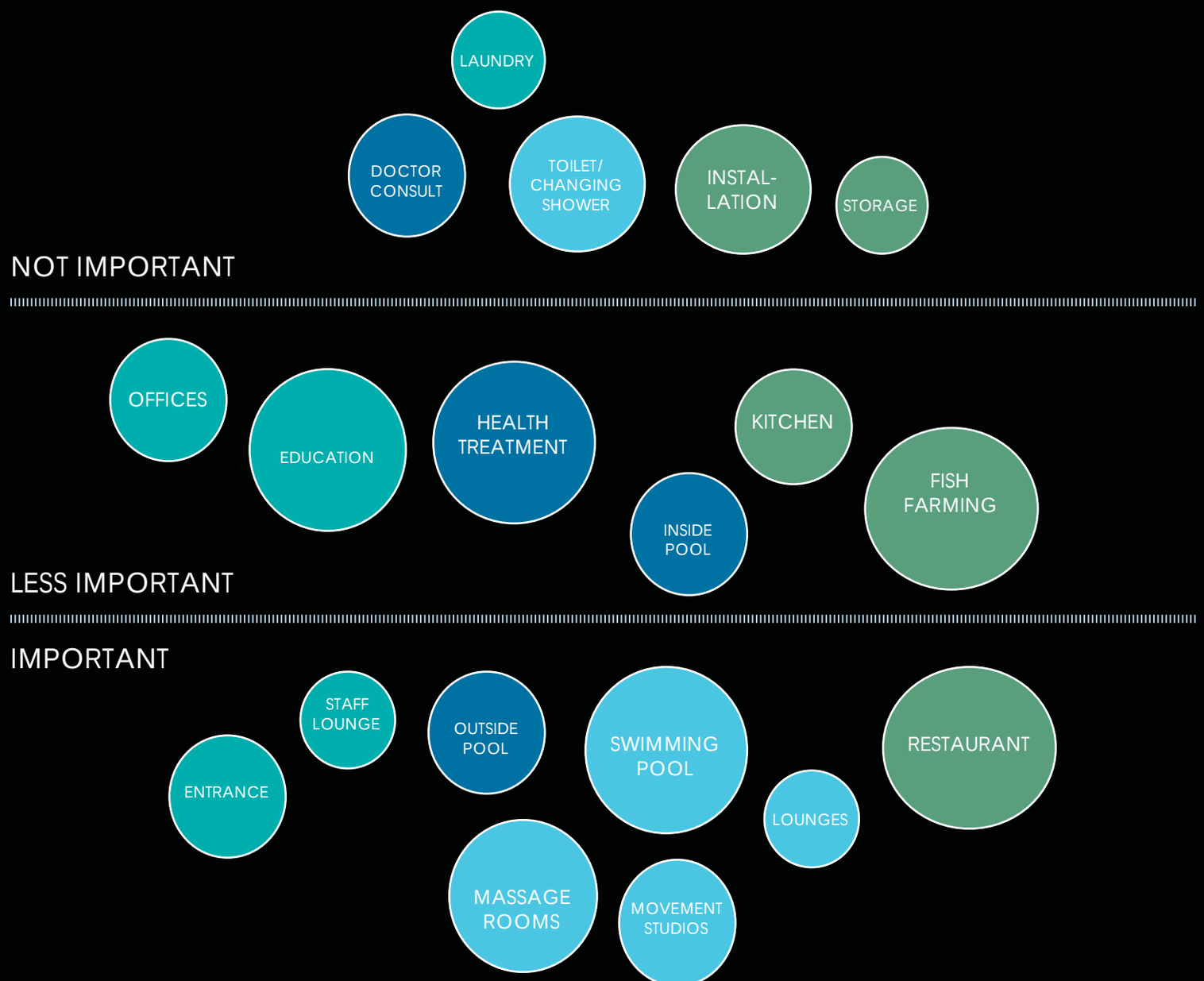
WALKING ON TOP OF THE STEAM



BUILDING CONCEPT
PROGRAMMES



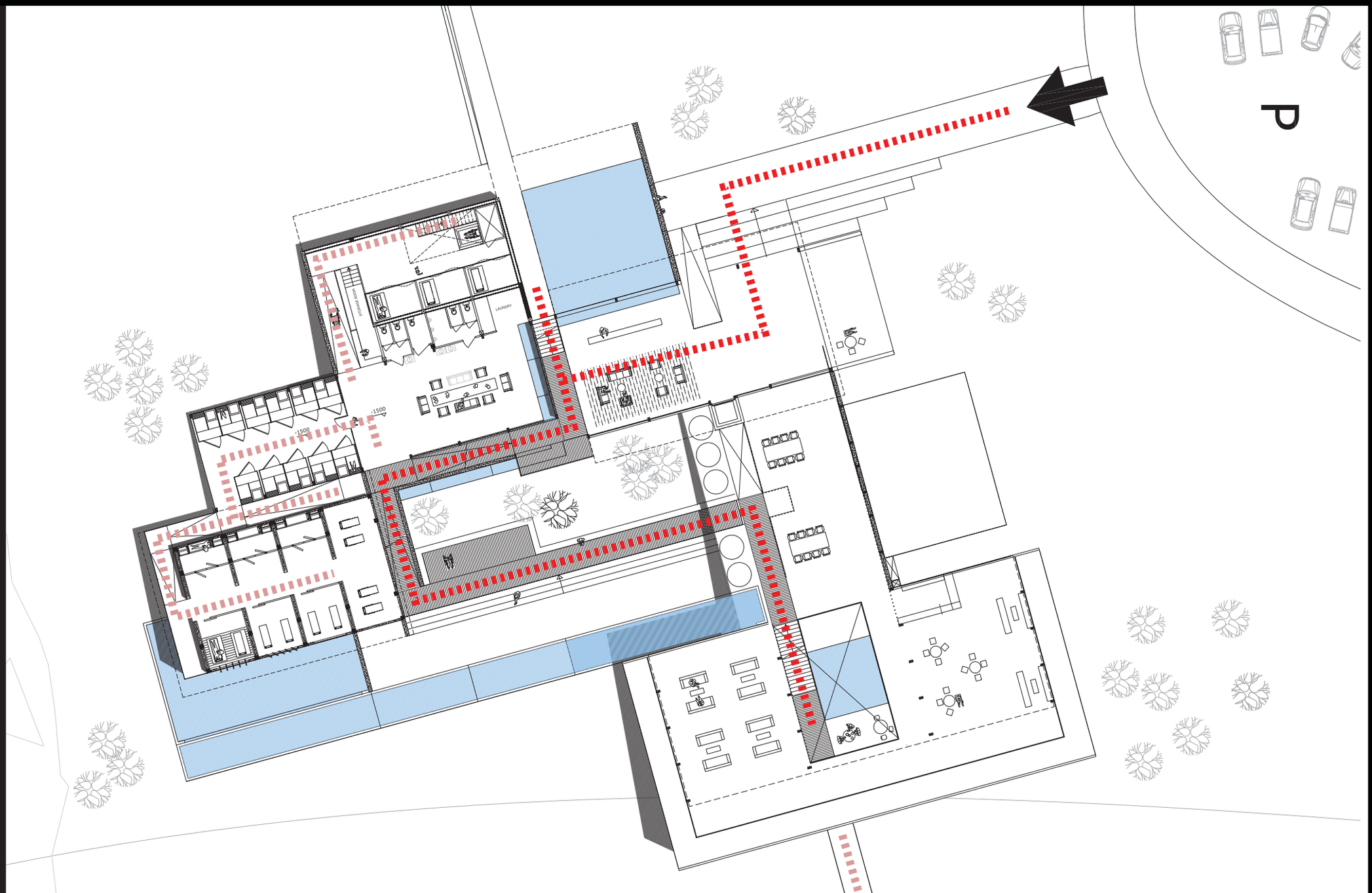
BUILDING CONCEPT
VIEW



BUILDING CONCEPT
FORM AND VIEWING AXIS

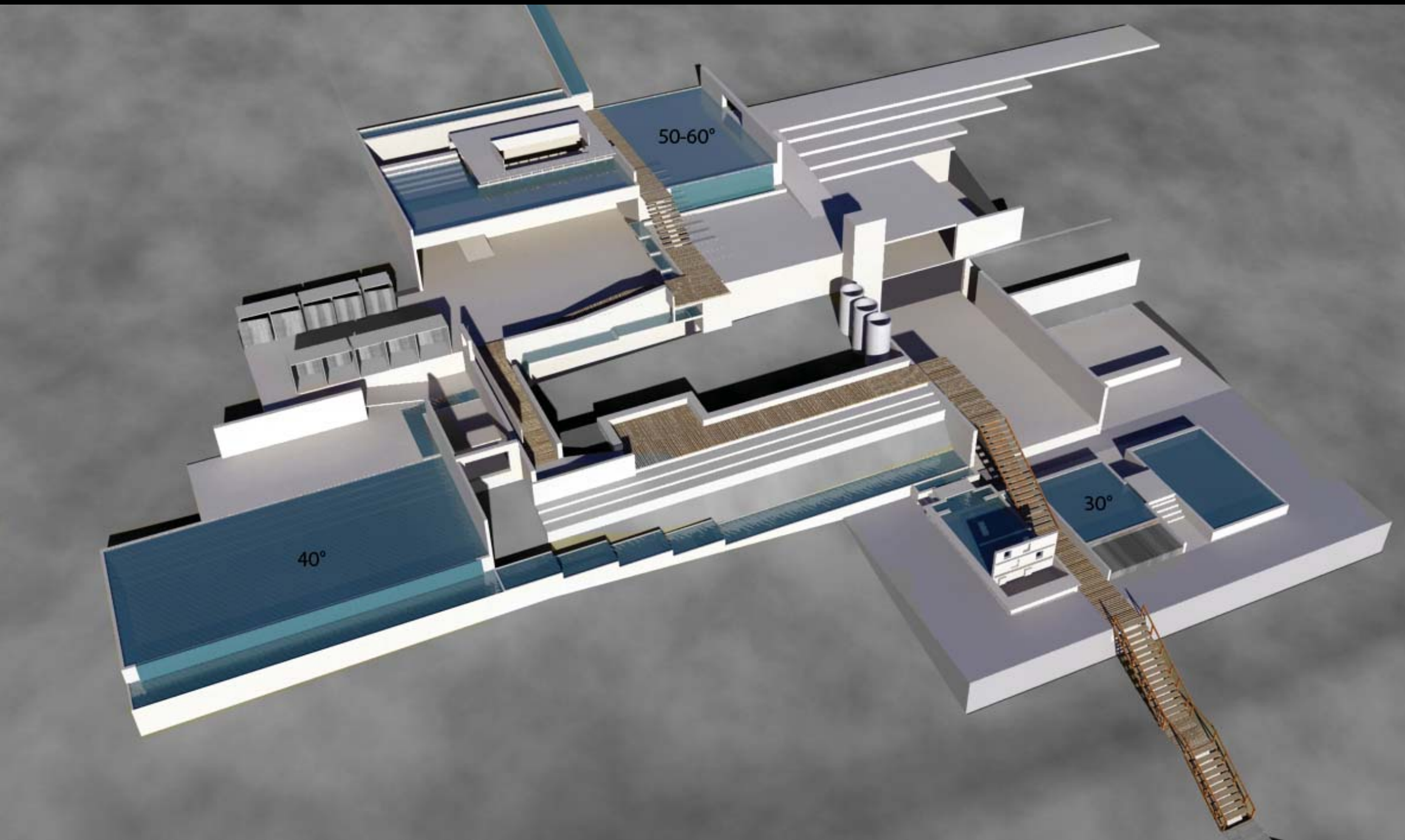
GEOTHERMAL SPA

SITUATION ON SITE 1:200 AND THE ROUTING



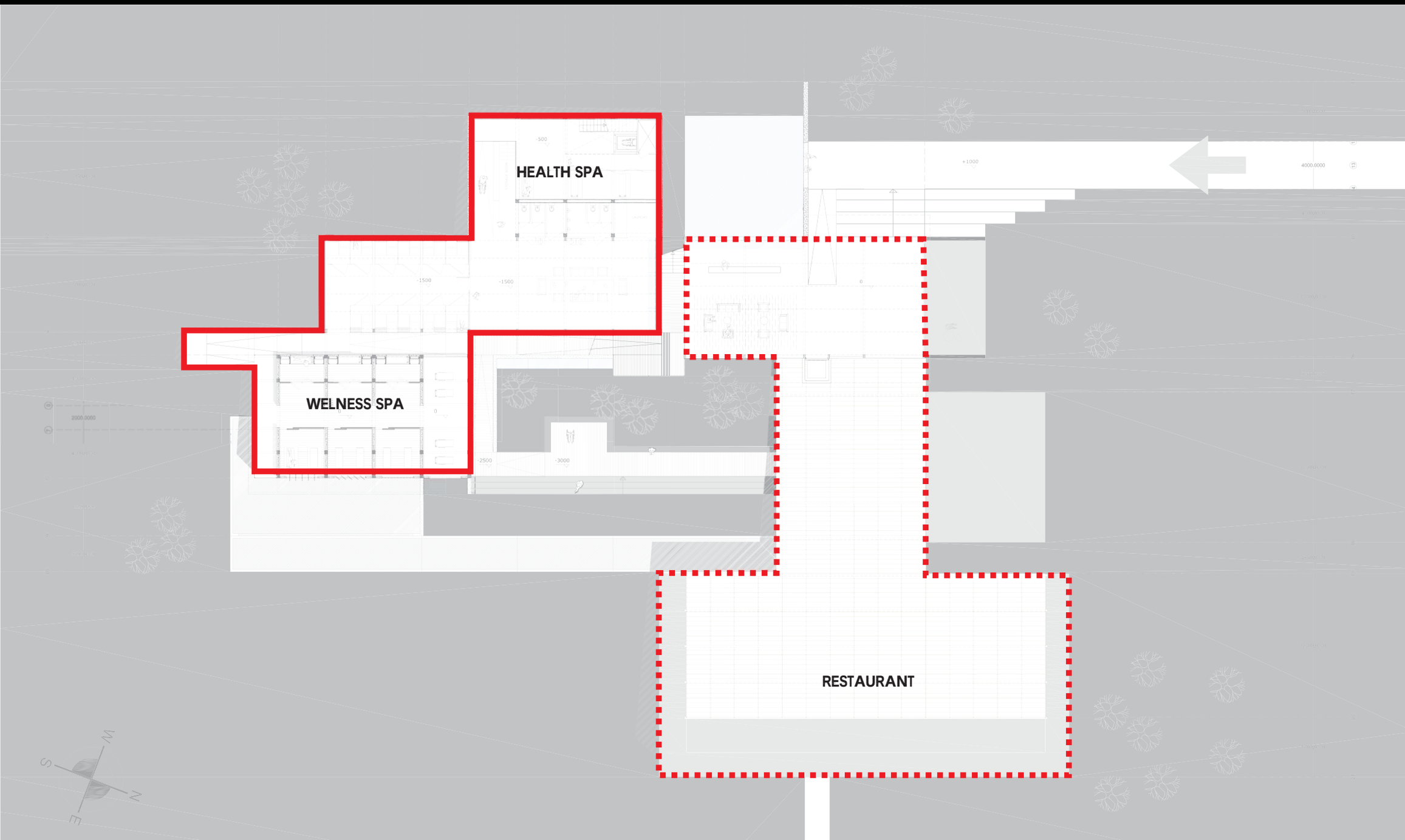
GEOTHERMAL SPA
ENTRANCE

GEOTHERMAL SPA
WATERFLOW IN THE BUILDING

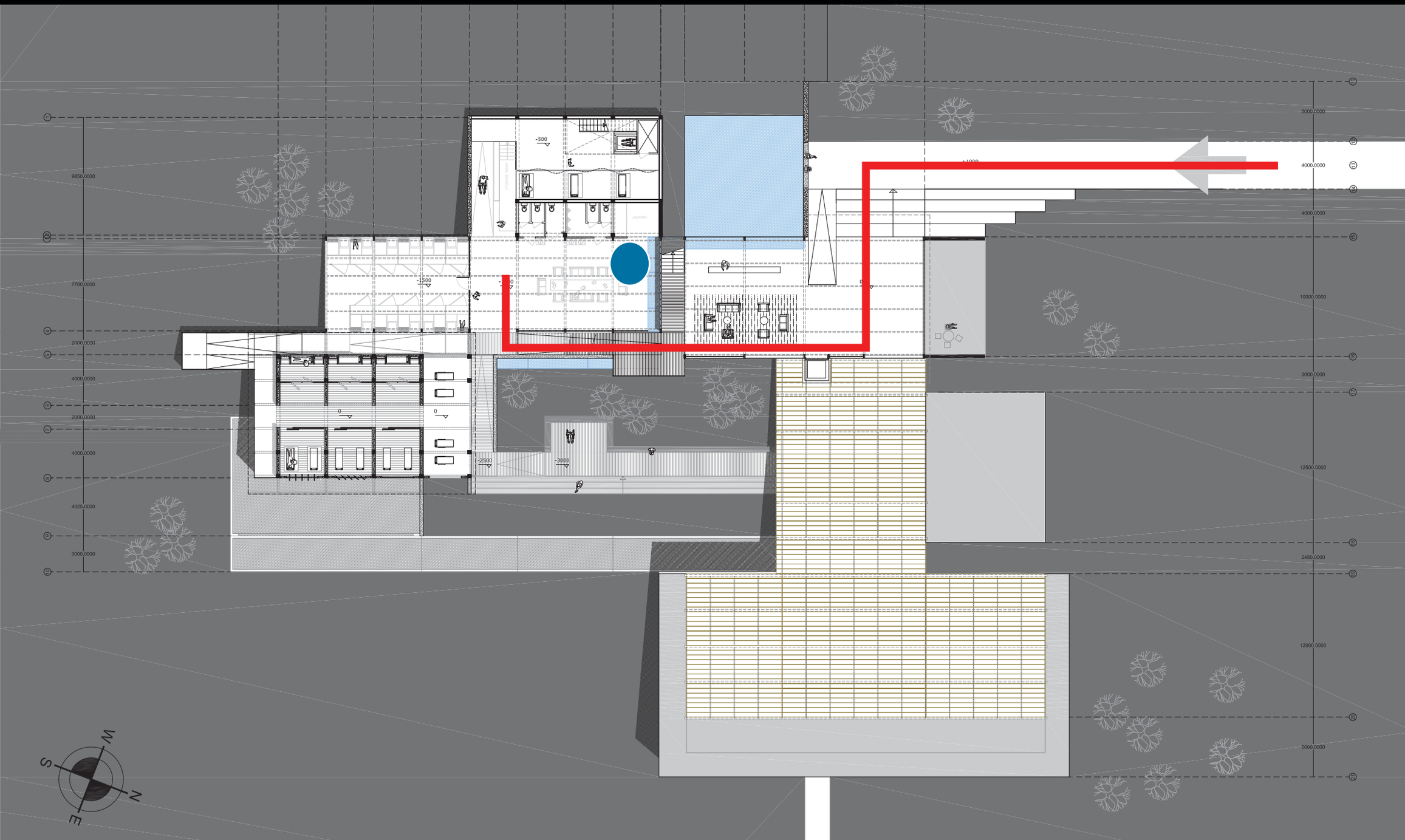


GEOTHERMAL SPA
OUTSIDE AND INSIDE

GEOTHERMAL SPA
SEMI -PRIVATE/PUBLIC SPACES



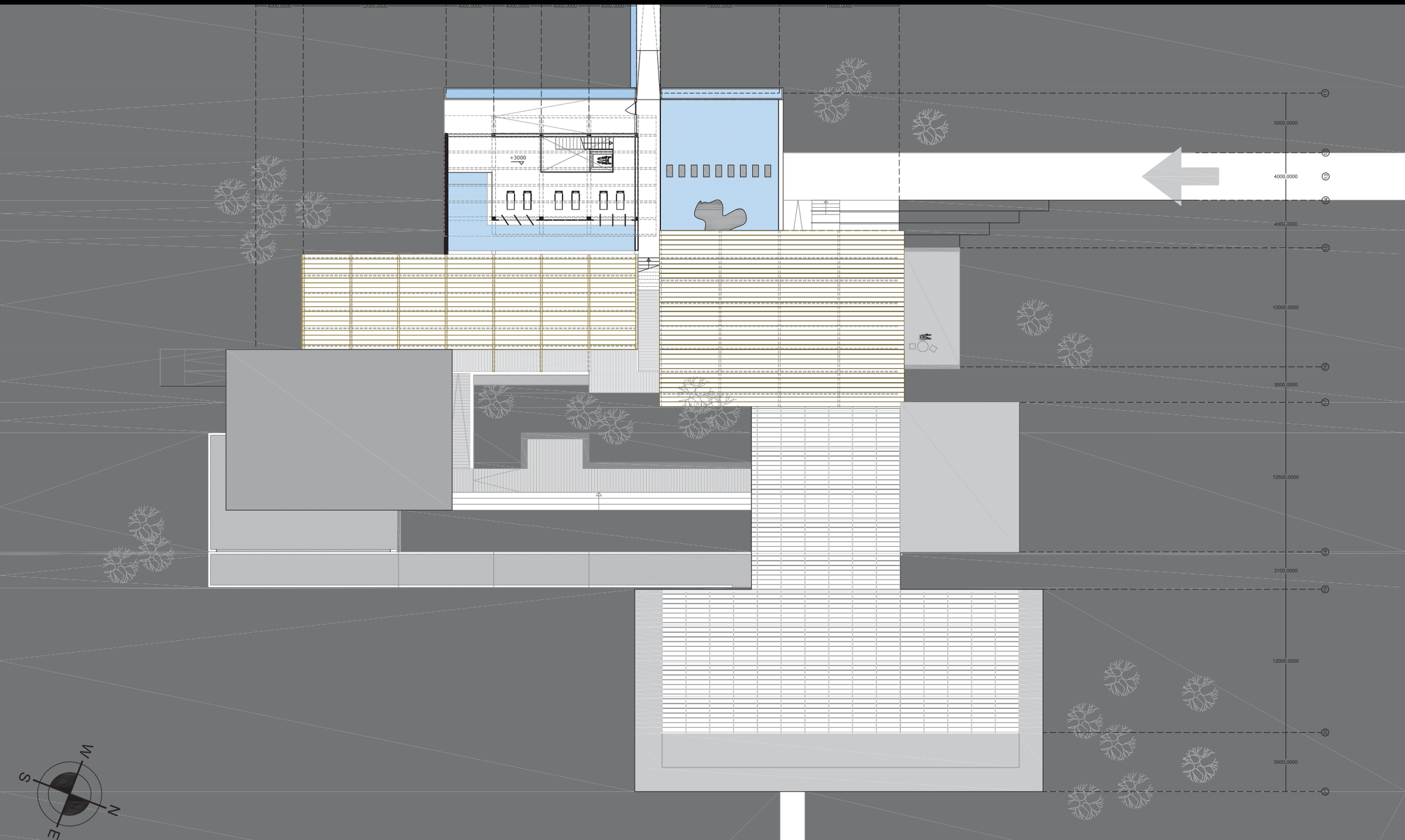
GEOTHERMAL SPA
PLANS



GEOTHERMAL SPA
WAITING ROOM

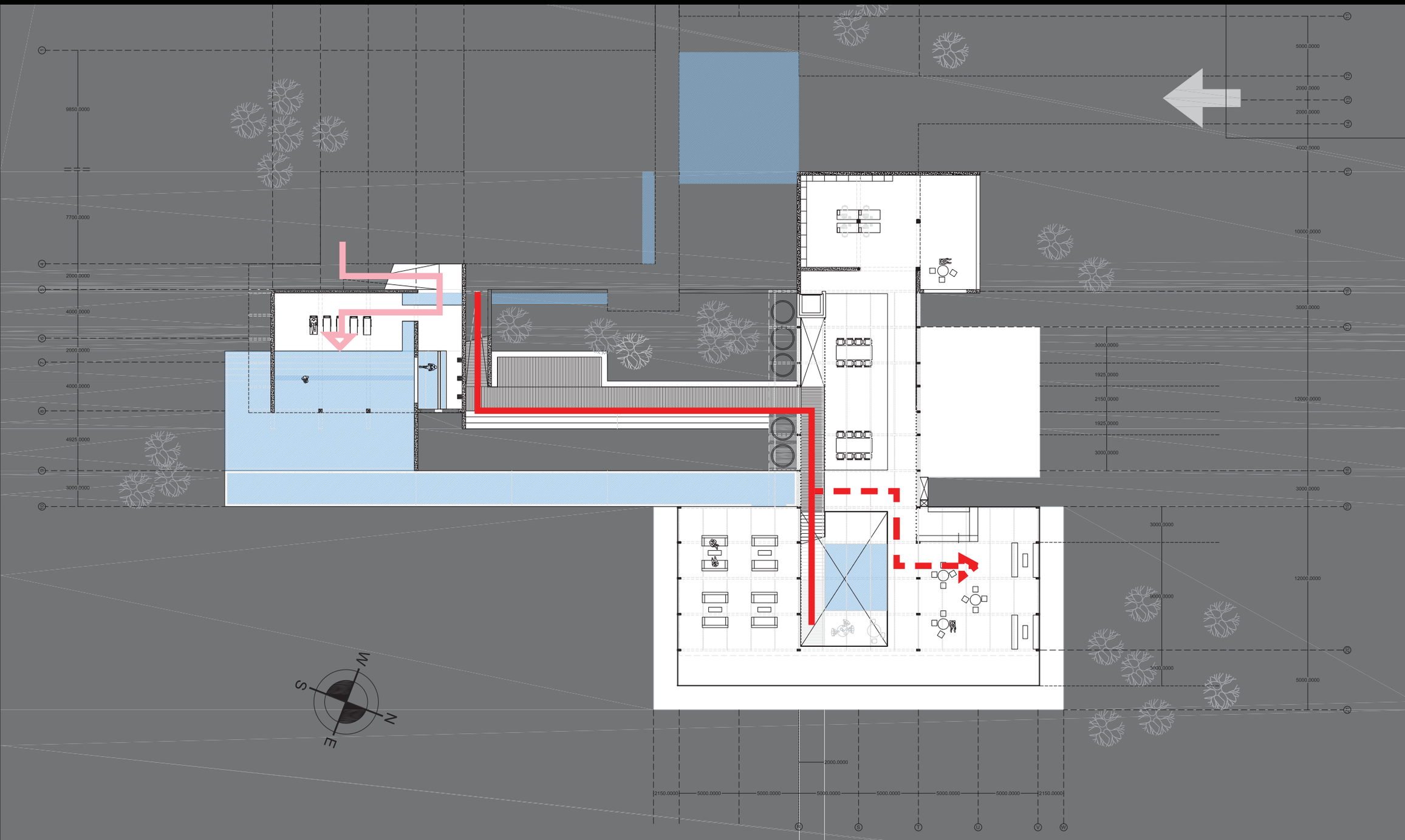
GEOTHERMAL SPA
VIEW TO THE LAKE

GEOTHERMAL SPA
PLANS



GEOTHERMAL SPA
HEALTH SPA

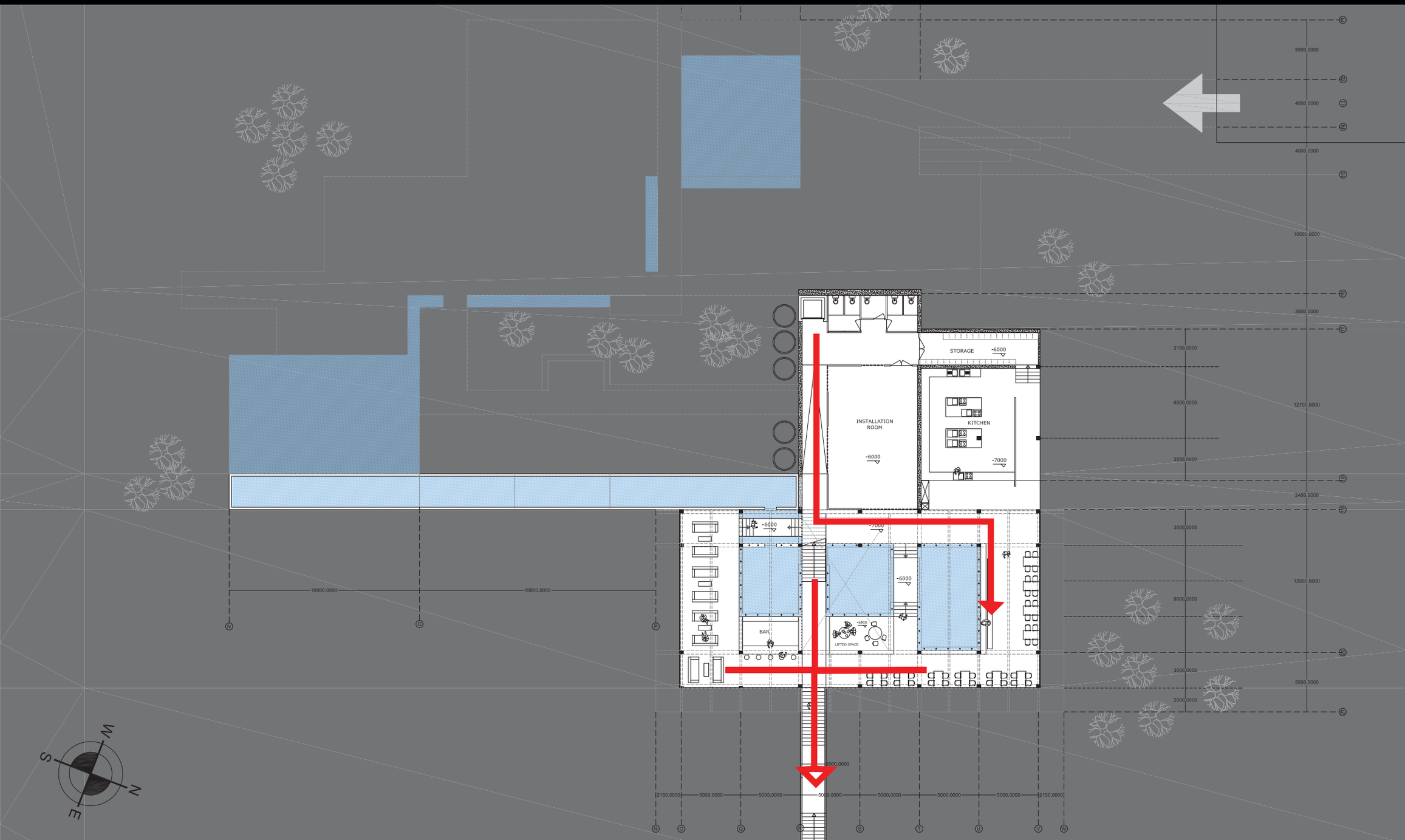
GEOTHERMAL SPA
PLANS



GEOTHERMAL SPA

WELNESS SPA

GEOTHERMAL SPA
PLANS

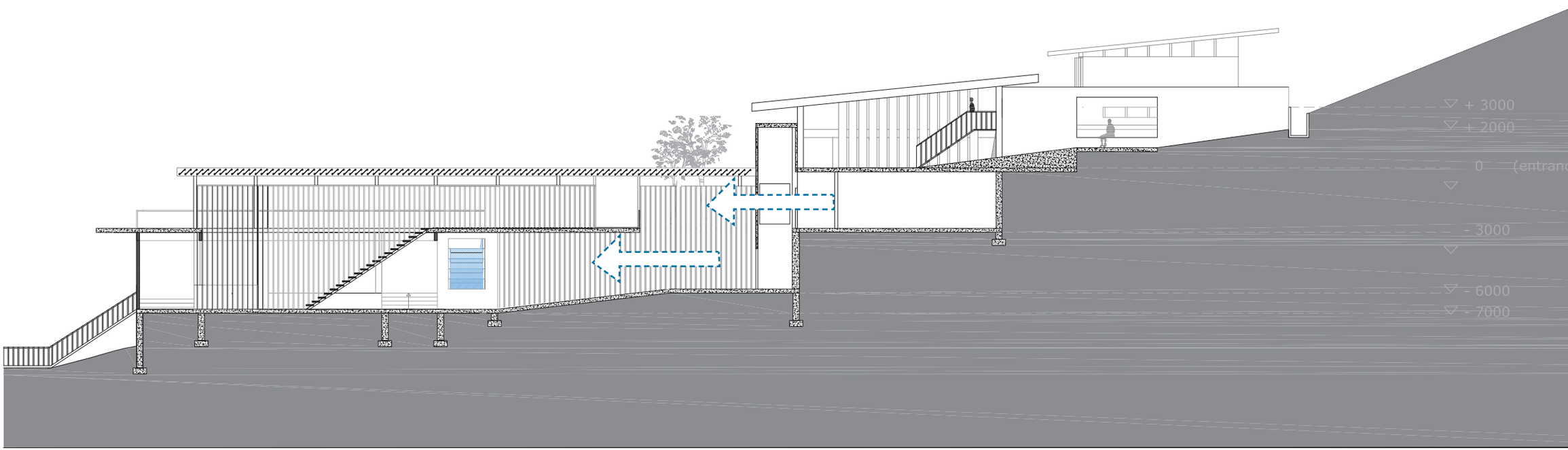


GEOTHERMAL SPA
RESTAURANT

GEOTHERMAL SPA
RESTAURANT

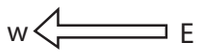
GEOTHERMAL SPA
CONSTRUCTION

GEOTHERMAL SPA
SECTIONS DETAILS

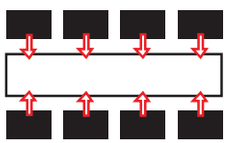


GEOTHERMAL SPA
TRADITIONAL ARCHITECTURE PRINCIPAL

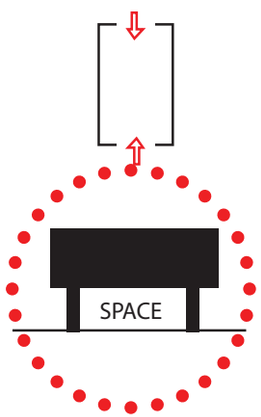
COLOURS
RED CLAY : THE HUMAN WORLD
WHITE CHALK : THE WORLD OF GOOD SPIRIT ABOVE
BLACK CHARCOAL: THE UNDERWORLD



AXIAL LENGTH
FROM EAST TO WEST



CENTRAL SQUARE
ALL THE HOUSES FRONT DOORS ARE SITUATED ON THE CENTRAL SQUARE



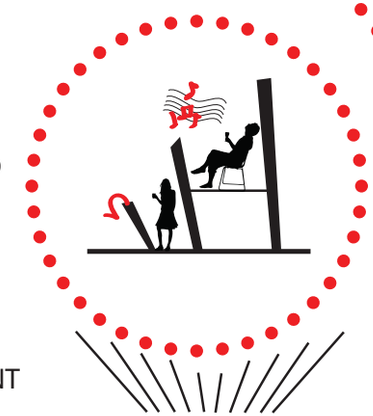
TWO ENTRANCES
THE ENTRANCES ARE POSITIONED IN THE FRONT AND IN THE BACK FACADE

SPACE UNDERNEATH
THE SPACE UNDER THE TILTED STRUCTURE ARE USUALLY USE AS EXTRA SPACES (STORAGE OR SHADED DAYTIME WORKSPACE)

ROOF PROPORTION
THE ROOF PROPORTIONS ARE USUALLY BIGGER THAN THE SIDE FACADE

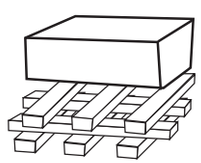
REPETITIONS
THE BUILDINGS ARE SITUATED NEXT TO EACH OTHER CREATING A LOT OF REPETITIONS

STACKING
BUILDING ON TOP OF A BUILDING
ALSO OCCURS IN SOME OF THE ARCHITECTURE

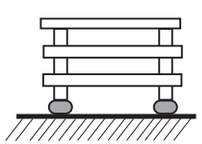


LAYERING
THE BALCONIES IN THE FACADE ARE LAYERED AND TIERED ACCORDING TO FUNCTIONS

THE ROOF STRUCTURE
THE RIDGES ARE EXTENDED FROM THE MIDDLE STRUCTURES

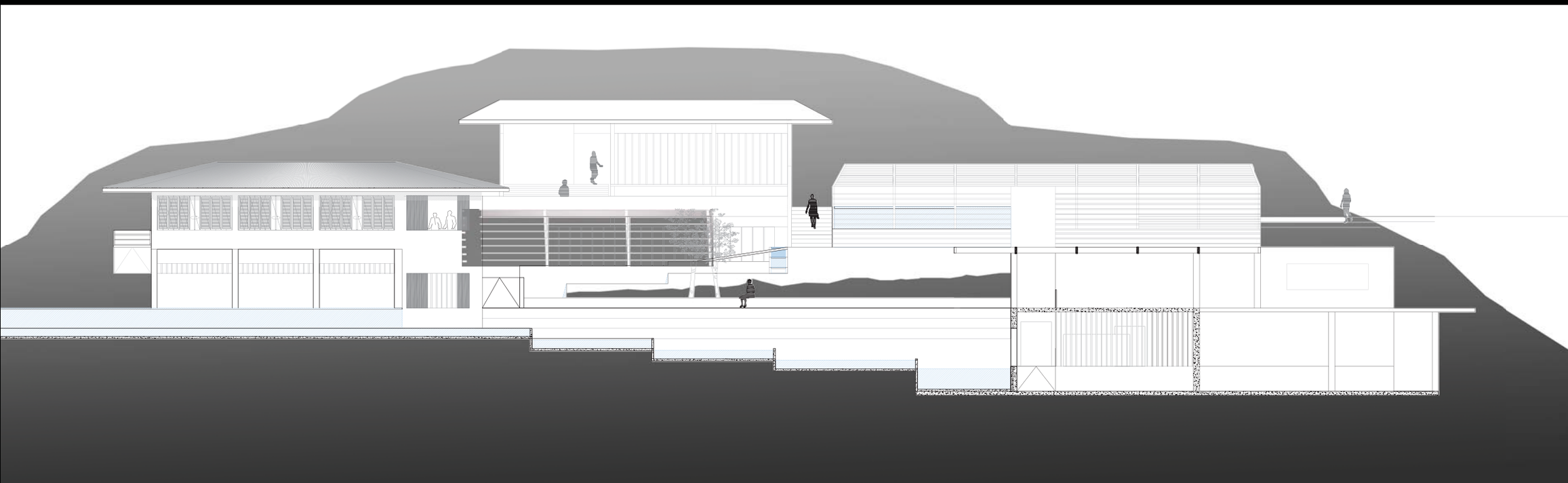


STRUCTURE POSTS
THE POSTS ARE THICK BEAMS WITHOUT NAILS STACKED ON TOP OF EACH OTHER, THE WALLS ARE USUALLY NOT LOAD BEARING

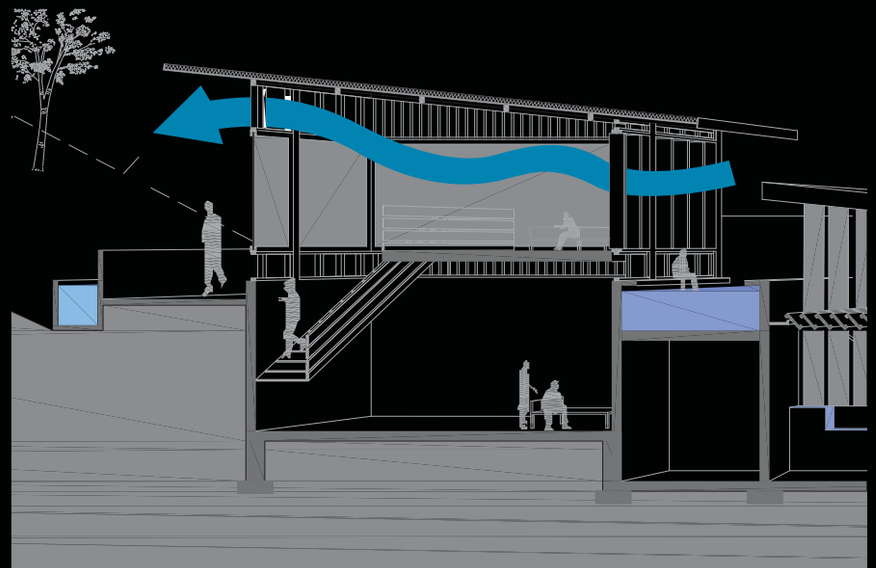


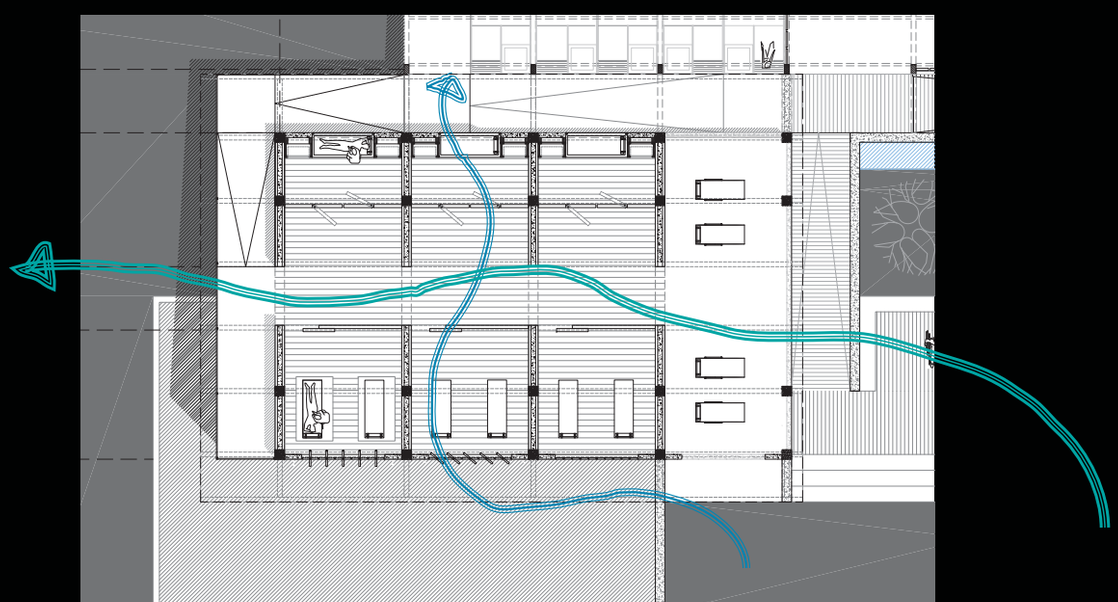
FOUNDATION (FLEXIBLE STRUCTURE)
THE FOUNDATION ARE CONSTRUCTED WITH HIGH POLES ON STONE

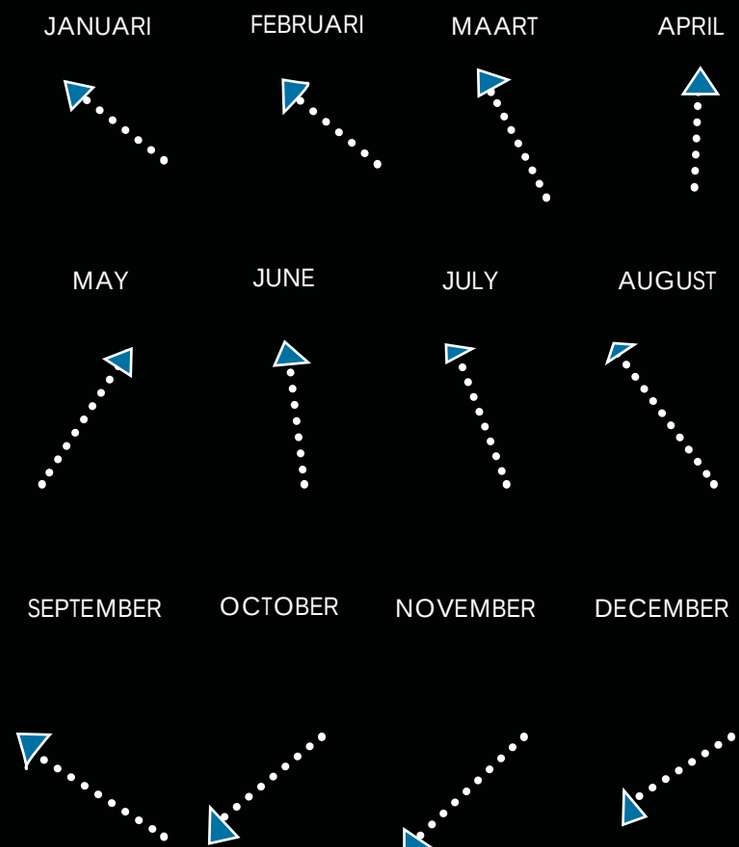
GEOTHERMAL SPA
SECTIONS WATER CASCADING



GEOTHERMAL SPA
CLIMATE ADAPTING





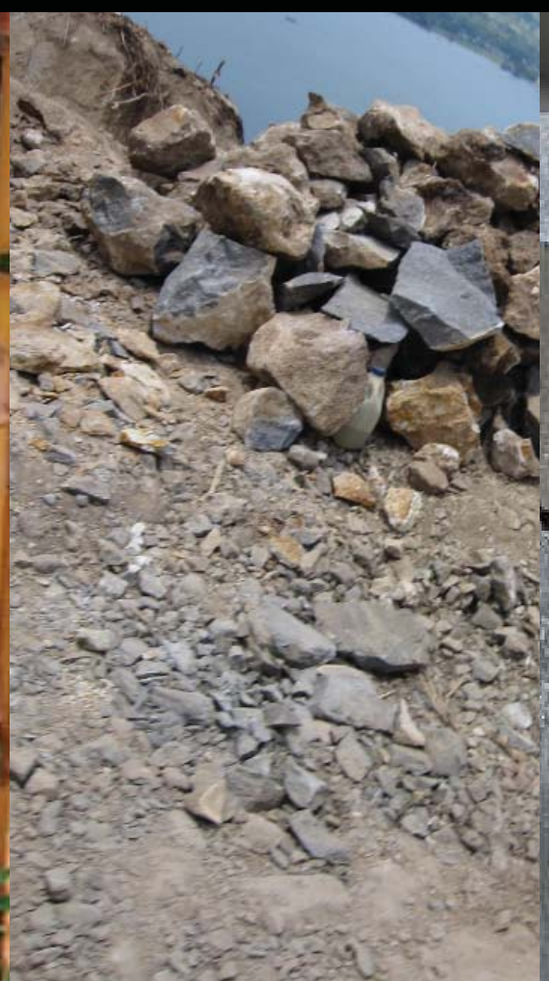


MATERIALS
MAIN MATERIALS

INDONESIAN MAHOGANY
(TOONA SURENI)
growth 4 cm/year

BAMBOO
growth 7 cm-40 cm/day

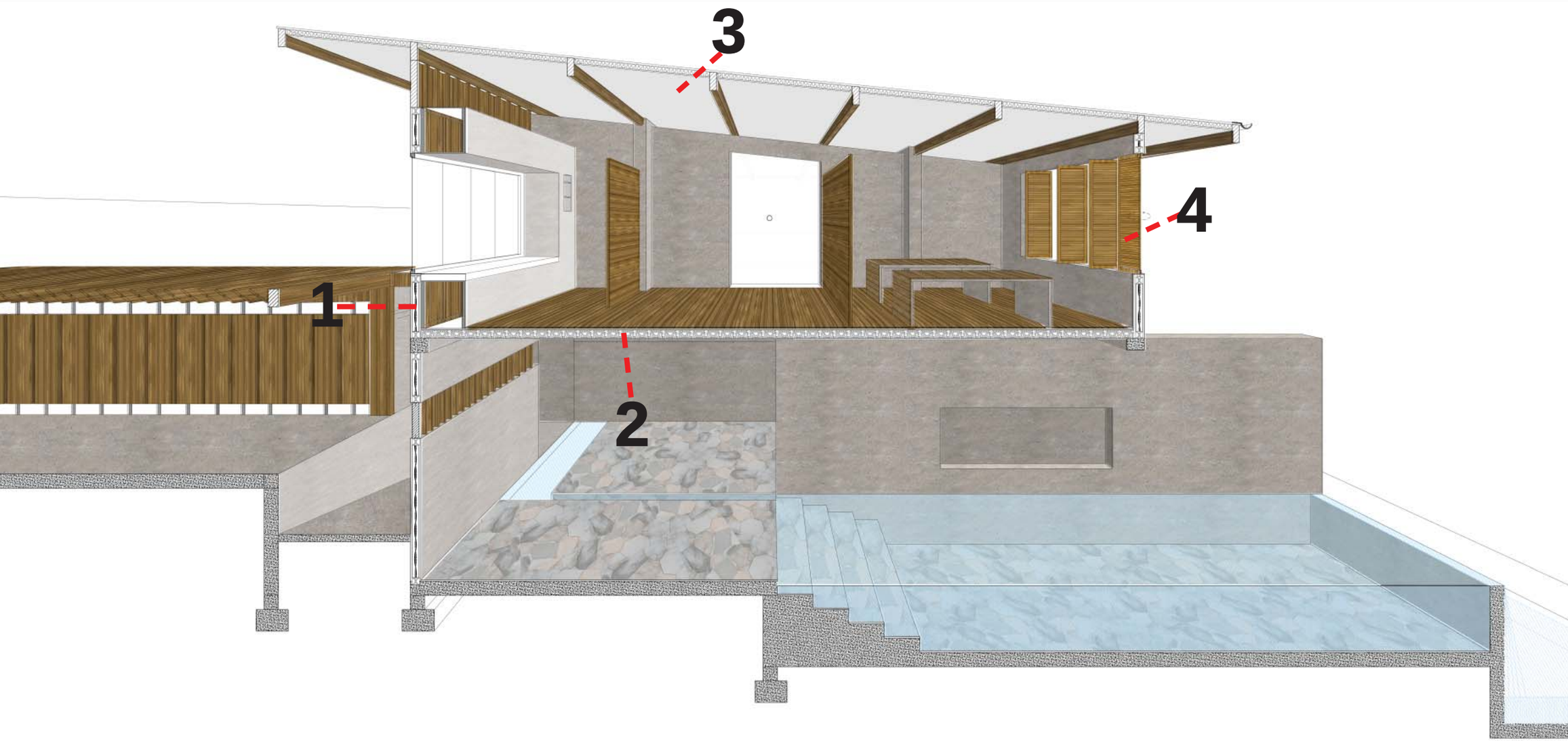
NATURAL LOCAL STONES

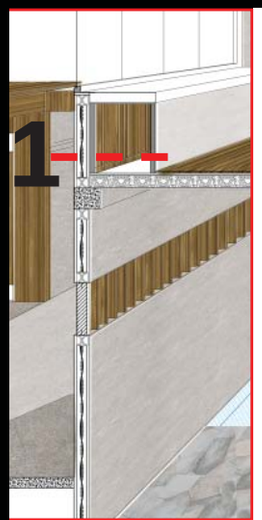


CONCRETE

GEOTHERMAL SPA

SECTIONS DETAILS: the materials





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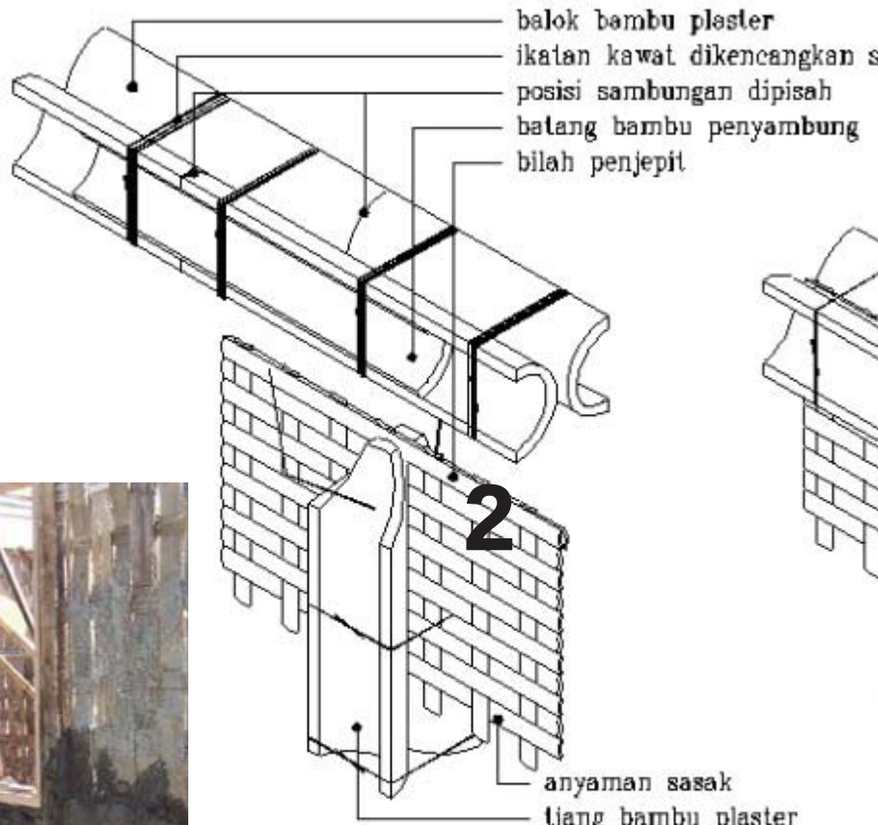
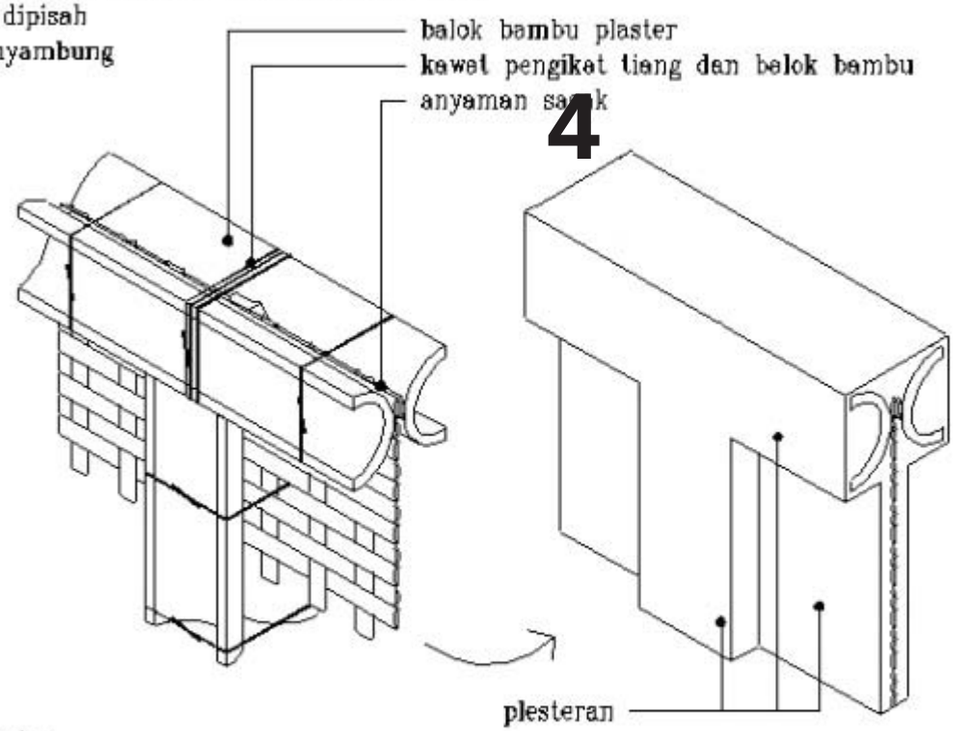
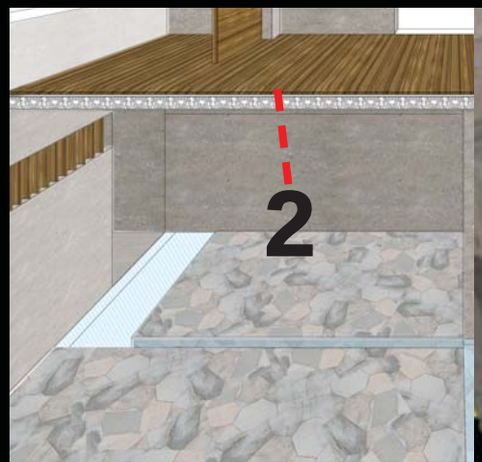


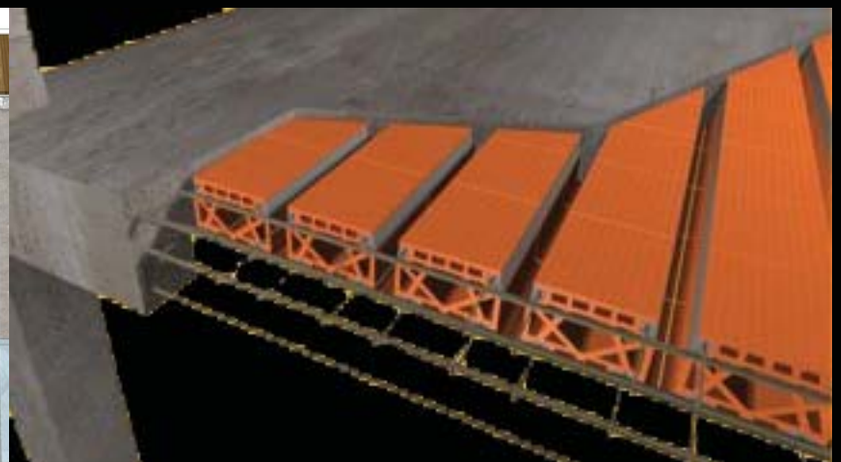


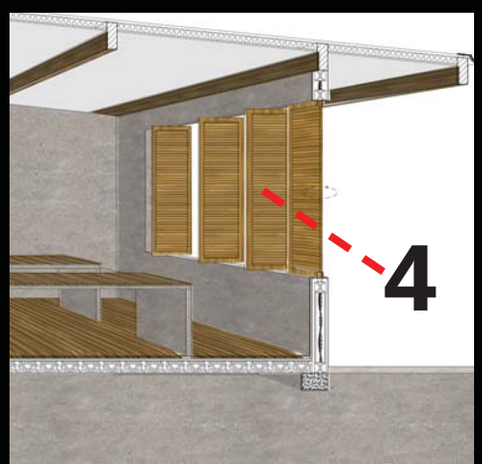
Ujung atas kolom dilubangi dengan bor untuk kemudian diikat bersama balok dengan kawat beton, kawat, tali ijuk atau tali bambu.

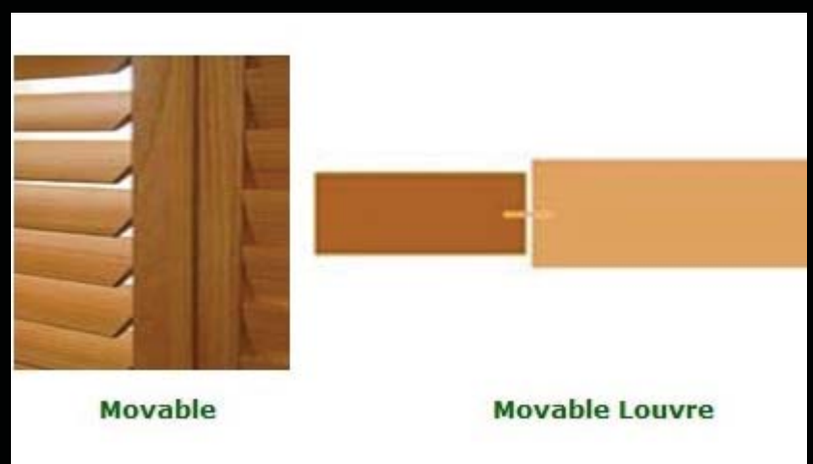
GEOTHERMAL SPA

SECTIONS DETAILS: Ceramic composite concrete



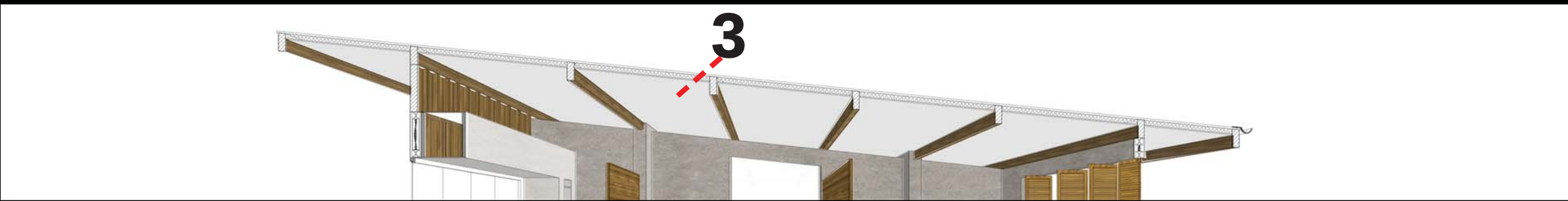


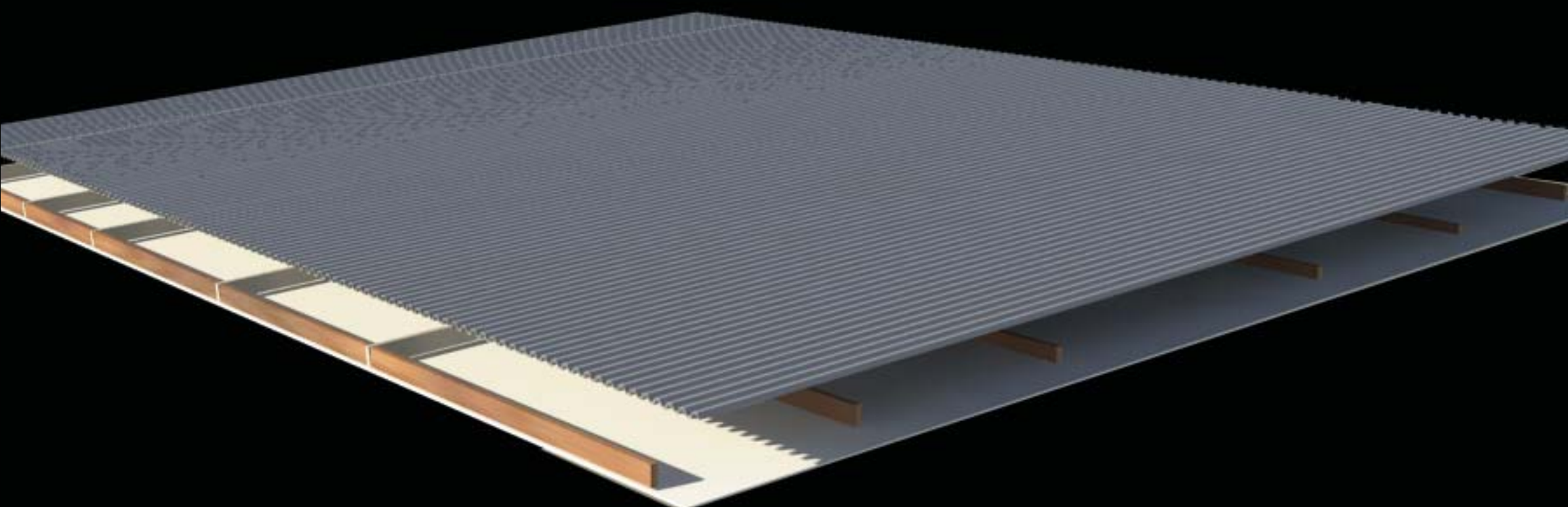




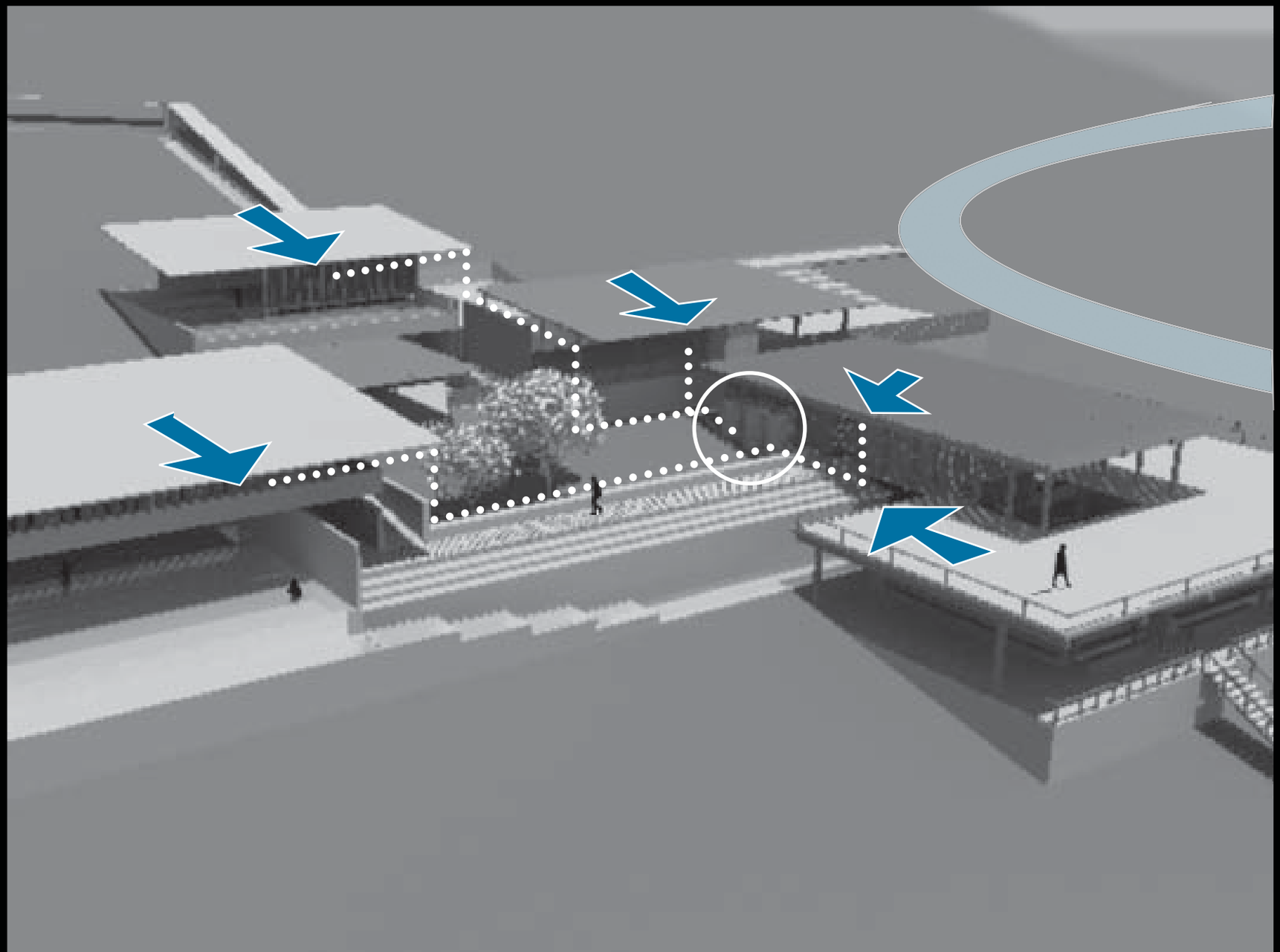
GEOTHERMAL SPA

SECTIONS DETAILS: roof panel





GEOTHERMAL SPA
RAINWATER CATCHMENT

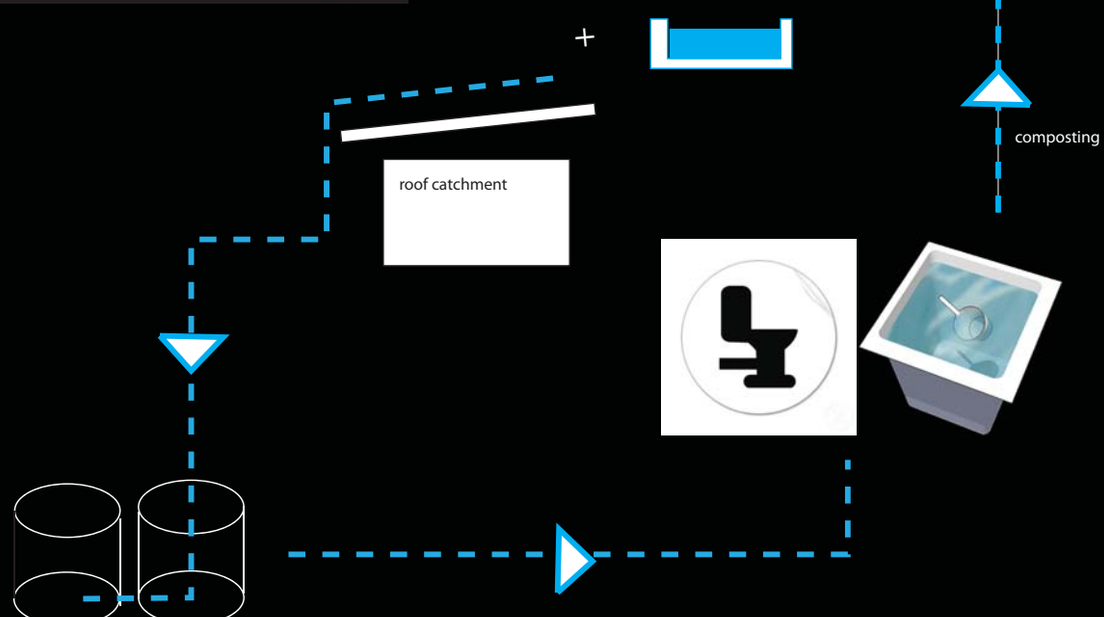


GEOTHERMAL SPA
RAINWATER CATCHMENT

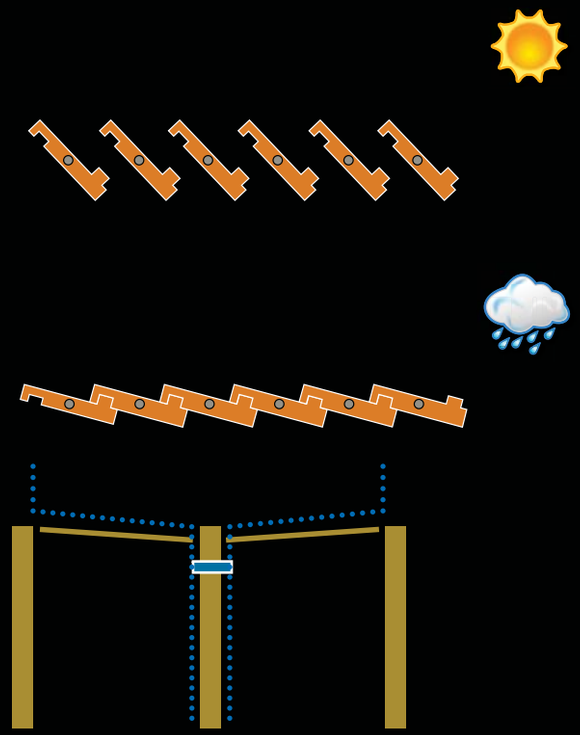
Containable rainwater												
Total Roof surface	1827,623 m2											
Month	**Jan**	**Feb**	**Maart**	**Apr**	**Mei**	**Jun**	**Jul**	**Aug**	**Sept**	**Okt**	**Nov**	**Dec**
mm/m²	137,22	155,44	192,33	125,11	34	89,44	180,78	185	135,11	73,2	187,11	211
days with rain	8	5	16	16	16	7	11	15	15	16	18	12
dagen zonder regen	23	23	15	14	15	23	20	16	15	15	12	19
No. Days in the month	31	28	31	30	31	30	31	31	30	31	30	31
mm/day	4,4	5,5	6,2	4,2	1,1	3	5,8	6	4,5	2,4	6,2	6,8
Containable rainwater	8042	10052	11331	7676	2010	5483	10600	10966	8224	4386	11331	12428

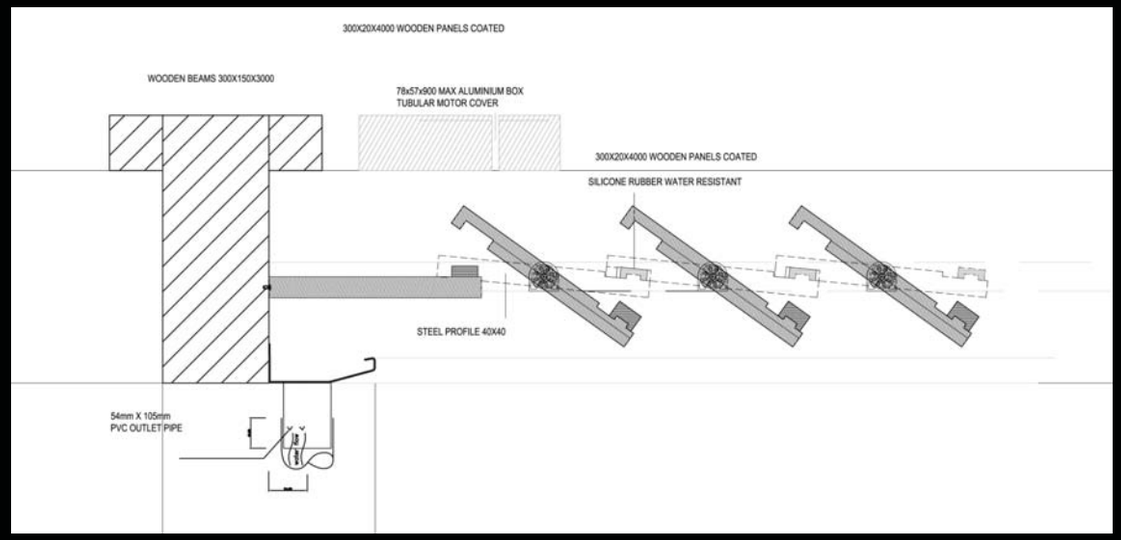
Water usage	
No. Of visitors per day	60
Toilet water (L) pp/pd	10
Mandi water (L) pp/pd	15
Total water per day(L)	1500
Total water per month (L)	46500
Largest amount of dry days	23
Needed water storage	34500

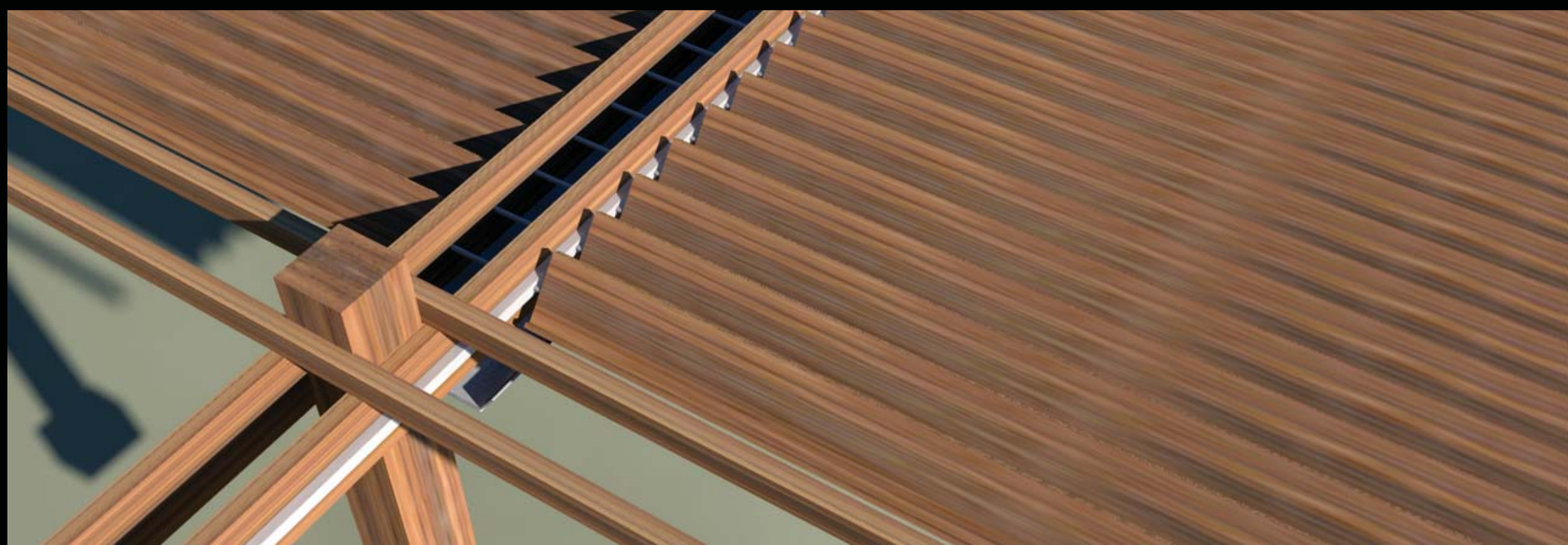
Water Tanks	
5 water tanks with r= 0,96 m and h=3 m.	
Capacity per tank	8,681472
Total capacity in L.	43407,36



GEOTHERMAL SPA
CLIMATE ADAPTING







CONCLUSION
CHANCES

ELECTRICITY

TOURISM

CLEAN ENERGY

THANK YOU

FIRST MENTOR
ANNE LOES NILLESEN

SECOND MENTOR
ARJAN VAN TIMMEREN

Royal Haskoning

BAPPEDA SAMOSIR

PERTAMINA GEOTHERMAL ENERGY

INDONESIAN GEOTHERMAL ASSOCIATION

UNIVERSITEITSFONDS DELFT

Question(s)?