

# LIBERLAND

# DEVELOPMENT

**Liberland is a beacon of liberty to the world. It is a flourishing, prosperous, attractive, and fun city existing in harmony with its sensitive surrounding ecology.**

## Site Development

The annual flooding and sensitive wetlands make much of the available land unviable for development. Developing the entire area would be devastating to the local ecology and could alter the path of the Danube river during floods.

The city will be built on two developed areas taking advantage of existing high points. Low points will be retained as the spacious "Decentral Park" and the "Woods Woods" nature preserve covering the southern half of the peninsula. These areas are allowed to flood without damaging property or built infrastructure.

The developed areas will have a high residential density comparable to Paris, giving Liberland an urban sensibility in a compact, walkable neighborhood footprint.

Building heights will range up to 20 stories, with an average height of 10 stories.

## Infrastructure

Liberland's compactness makes walking, cycling, and microtransit the predominant modes of internal transportation. Most streets will be closed to general car traffic but will be wide enough to support utility and emergency vehicles.

A road from Croatia is the primary route for goods delivery, however a wharf also enables river freight and passenger transport. A canalized marina protects personal watercraft from the river current.

Connections to Croatian and Serbian power grids will provide reliable, redundant power supply with minimal footprint. This supply will be supplemented by a gas or nuclear power station which captures and distributes waste heat to buildings.

Large scale infrastructure can be financed and owned by Distributed Autonomous Organization mechanisms that incentivize long term lending while preserving attractive user fees during the buildout phase. Initial low interest rates paid by a small number of users will increase to high interest rates in later years, divided among more users. These systems will collect ongoing funds for maintenance and upgrades, ensuring that Liberland's infrastructure is never in disrepair.

## Industry

Liberland will naturally attract primary industries that thrive on unimpeded trade and innovation. This is likely to include financial services, software and blockchain development, medical research and services, and rapid prototyping.

## Land Use Planning

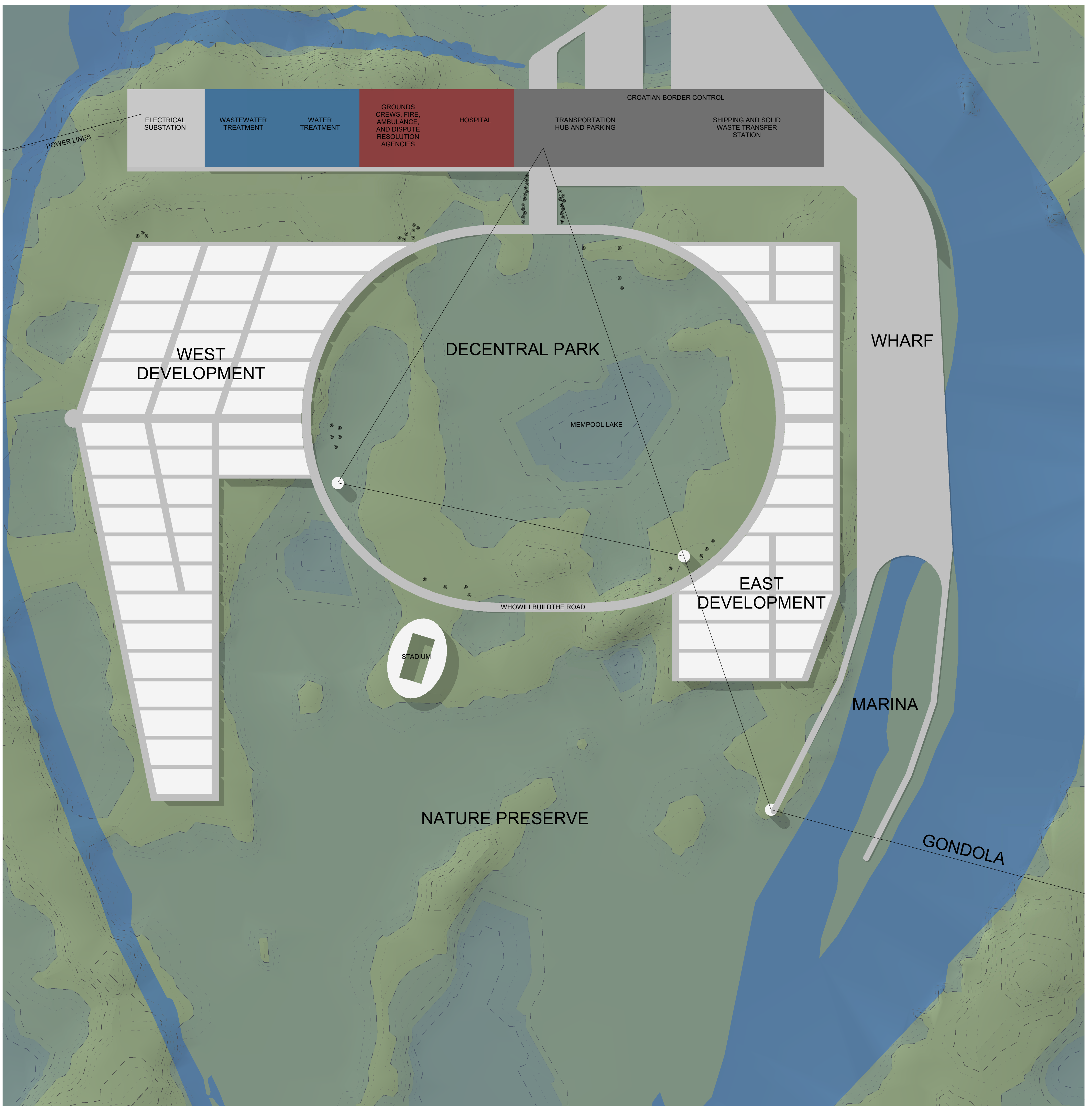
Rather than rigid master-planning, development goals can be achieved by establishing a system of costs and credits for developments that support the long-term goals of the Liberland community. Development goals may include density / building height, open space and right of way spacing and dimensions, daylight and view shed setbacks, etc.

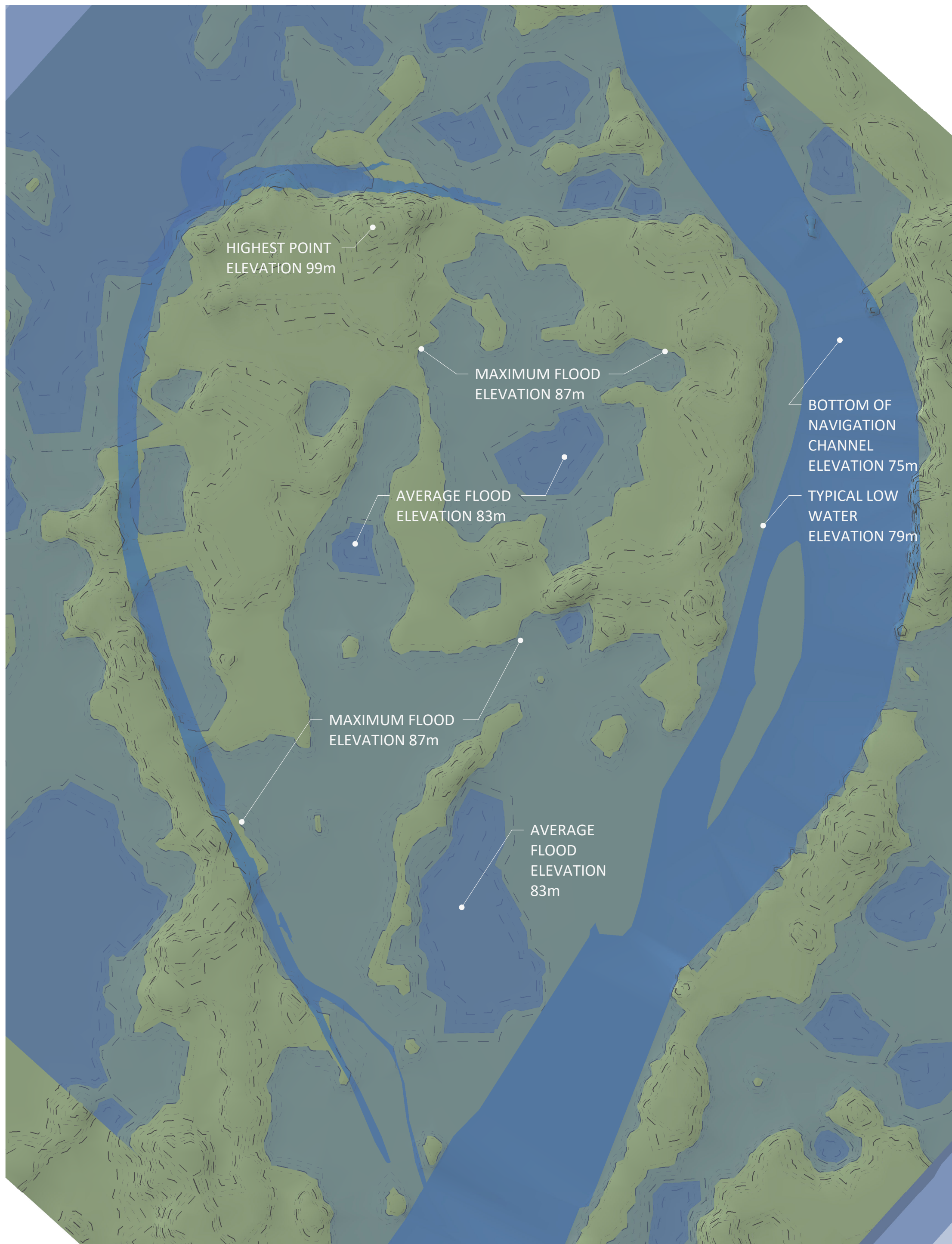
This can be executed in a blockchain based Decentralized Autonomous Organization (DAO), using smart contracts to collect fees from developers in escrow and award credits to them for achieving development goals.

## Napredak

The Napredak development is a destination in itself, with it's key attraction: "The Libertarianium" - a multifunctional landmark building with a Museum of Liberty, a full-dome theater, and conference and event facilities.

"The Agora" is a open air marketplace along the riverbank that is a lively demonstration of decentralized free market principles in action.





## THE LAND OF LIBERLAND

### Hydrology

5 million years ago, Liberland was at the center of the Pannonian Sea, a vast body of water stretching from the Alps and Dinarides to the Carpathian mountains. This sea dried out to form the low, flat Pannonian Basin with the Danube River and other tributaries draining this large watershed. Spring melt in the mountains delivers an enormous amount of water to the Danube, causing extensive and sometimes rapid seasonal flooding in these low-lying areas. This has created winding tributaries along the river's path known as meanders. The path of the Danube was altered in the 19th and 20th centuries to create a more direct navigation channel through the meanders. This artificial change to the river's path is the source of the border dispute between Croatia and Serbia that has left Liberland as unclaimed land.

### Topography

Liberland has very little change in topography over its land area, with a difference in elevation from the low point of the riverbank to its highest point of only 20 meters. Flooding and draining cycles have formed typical linear striations of high and low channels known as "foks." (Note: Topography shown may be imprecise but is believed to represent the general shape and elevations of the land.)

### Flooding

Even the river doesn't want Liberland to exist. The Danube annually floods an average of 4m above its typical low elevation of 79m. Maximum flood levels of 8m have been observed as recently as 2006 and 2013. This level of flooding may cover more than 50% of Liberland's land area in water.

Development is only proposed above this high flood elevation of 87m.

### Erosion / Sedimentation

This portion of the Danube tends to have erosion in the riverbed, causing sedimentation downstream near the Iron Gates. However, the river causes aggradation and degradation of the river bed from one side to the other as the river curves. The navigation channel is regularly dredged, contributing to further erosion and downstream sedimentation.

### Soil

Soil in this region is indicated to be "Eutric Fluvisol," also known as "mud." Flooding cycles deposit strata of fine sands, with drying cycles promoting microbial activity and mineralization in the deep topsoil. This is great for growing things, unless the thing you want to grow is a city.

Soils may have low bearing capacity and possibly expansive clays. Construction equipment may be unusable on the native soil. Organic and replacement of significant quantities of organic topsoil with imported gravels and structural fill will likely be required. Deep foundations such as piles will likely be required, which may be a challenge for building tall.

### Seismicity

Croatia has a history of devastating earthquakes, but areas of high seismic hazard are highly localized around Zagreb and in southern Croatia. Liberland has only a moderate seismic hazard, with Peak Ground Acceleration of 0.13 g.

Seismic design will be a consideration but is not expected to be a significant problem for taller buildings.

### Stormwater

With minimal vehicles, contamination of stormwater runoff will be limited.

Stormwater runoff will be treated in surface swales draining to lower areas of the site, with sand filters for areas requiring extra treatment.

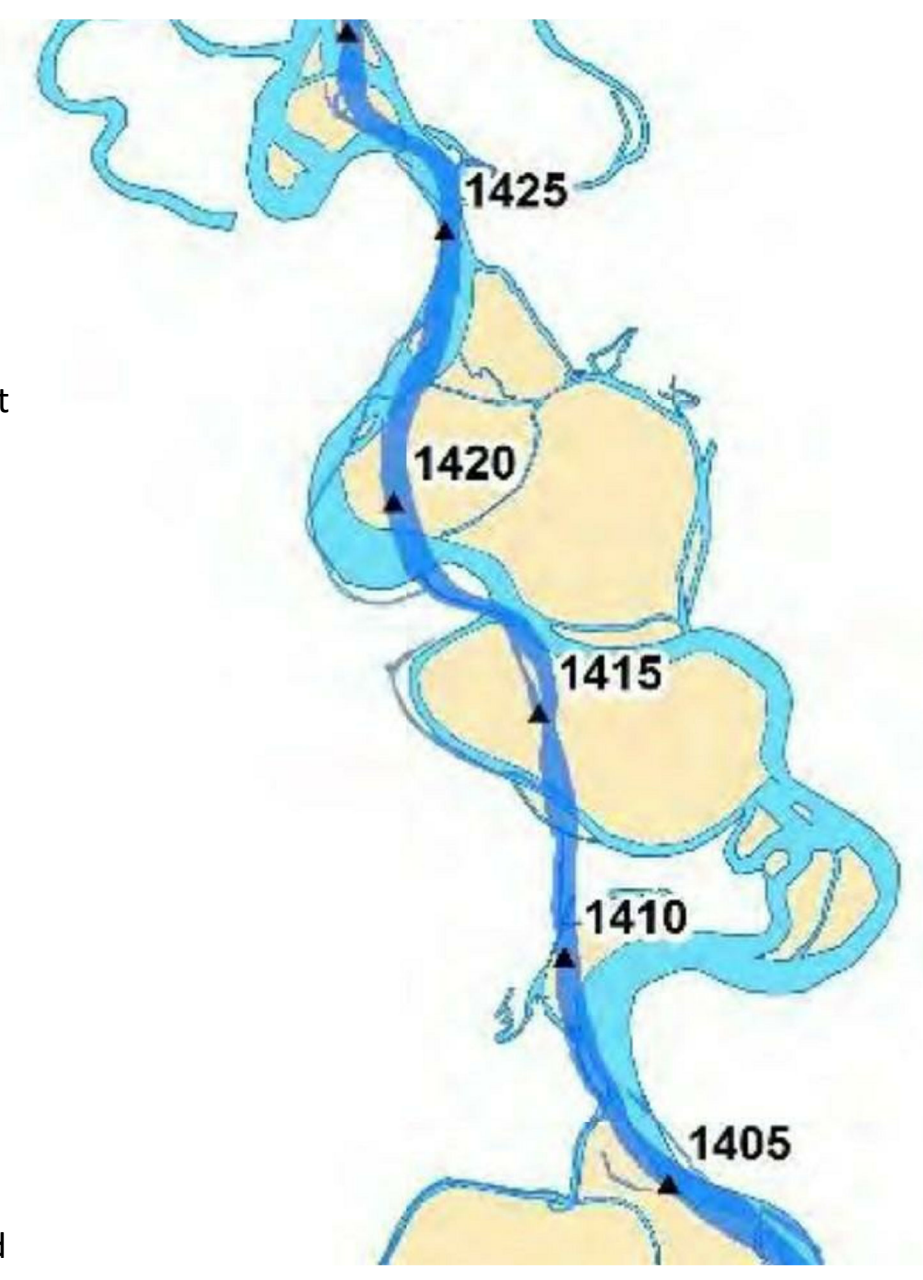


Image Source: Long-term Morphological Development of the Danube in Relation to the Sediment Balance  
Authors: Water Research Institute & project partners (BME, BOKU, OVI, NARW, NINWA, LEU, NIMH, EAEMOR, HRVOD, IZRS, TUM, JC, Plovač): Publisher: Water Research Institute (VIVVI), Bratislava, November 2019  
<http://www.intereg-danube.eu/danubedement>

### Wetlands

Liberland is surrounded by important wetlands. So important, in fact, that they have been designated "Wetlands of International Importance" by Ramsar, and have been described as some of the most important wetlands in their respective countries. These include Kopački Rit to the south in Croatia, Gornje Podunavlje to the east in Serbia (and maybe Croatia), and Duna-Drava National Park to the north in Hungary.

This speaks to the importance of the wetlands in Liberland. Several international organizations are interested in preserving sensitive wetlands areas throughout the Danube floodplains. Liberland's development should treat its wetlands with the utmost care, for the sake of the environmental and their international relations.

Development of low lying wetlands areas is not proposed.

### Habitat

Liberland is in a crucial location for biodiversity. The region is home to 20,000 birds and 55 species of fish, in addition to endangered insects, amphibians, turtles, and mammals like the Eurasian otter. According to Natura 2000, this portion of the Danube is the largest fish spawning ground in the river in central Europe.

Impacts to habitat from development, erosion, treated waste water, stormwater runoff, fertilizer use, dredging and canalization of the river, and river traffic should be carefully evaluated.

### Land Swap?

While the location of Liberland offers some unique opportunities, it also poses significant ecological, hydrological, engineering, and political challenges to development. Once Liberland earns recognition as an autonomous nation, it may be worth negotiating a land swap with Croatia or Serbia for another land parcel that is more viable for development. Liberland could offer to fund the preservation of the current Liberland parcel as a nature preserve for its new host nation.

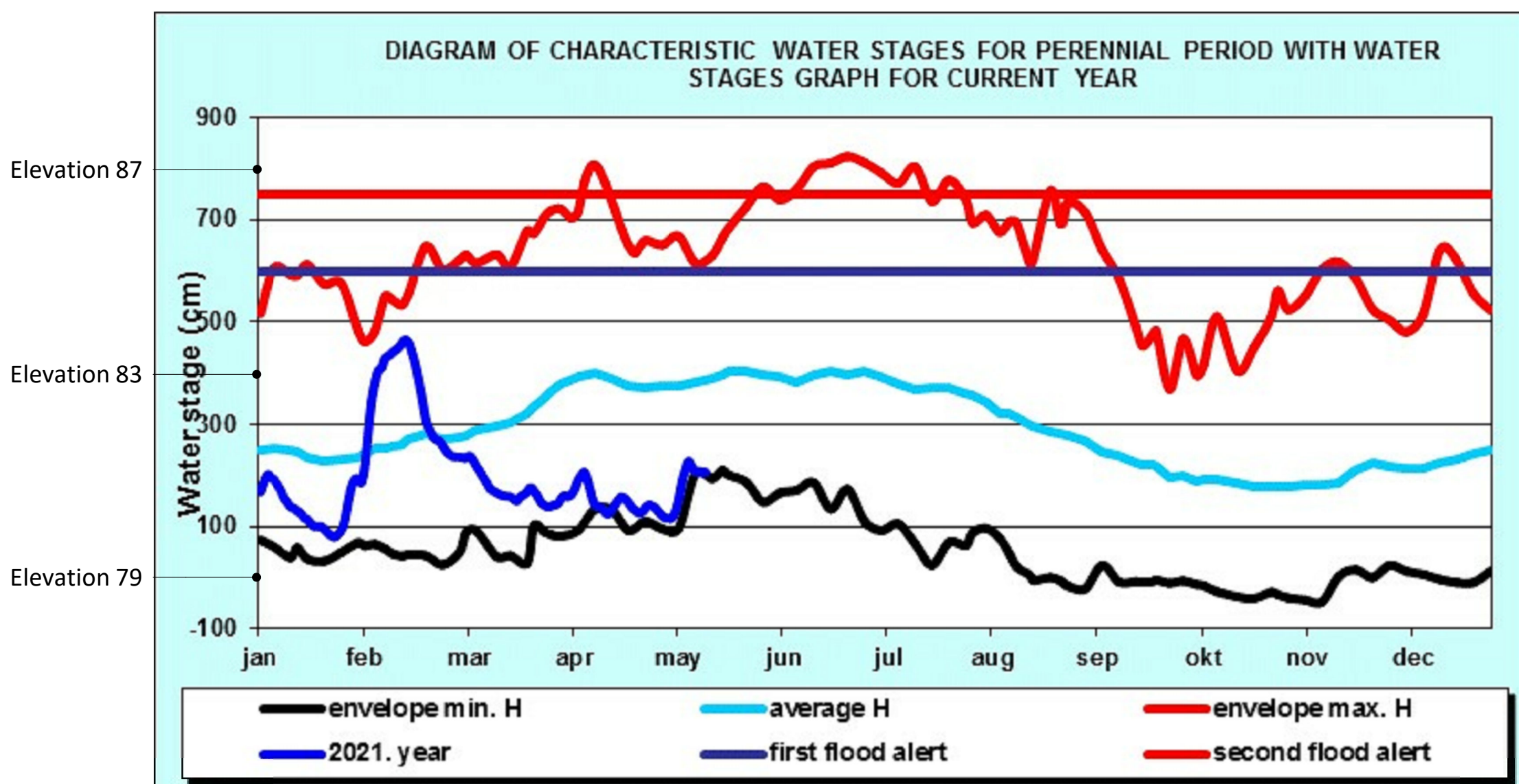
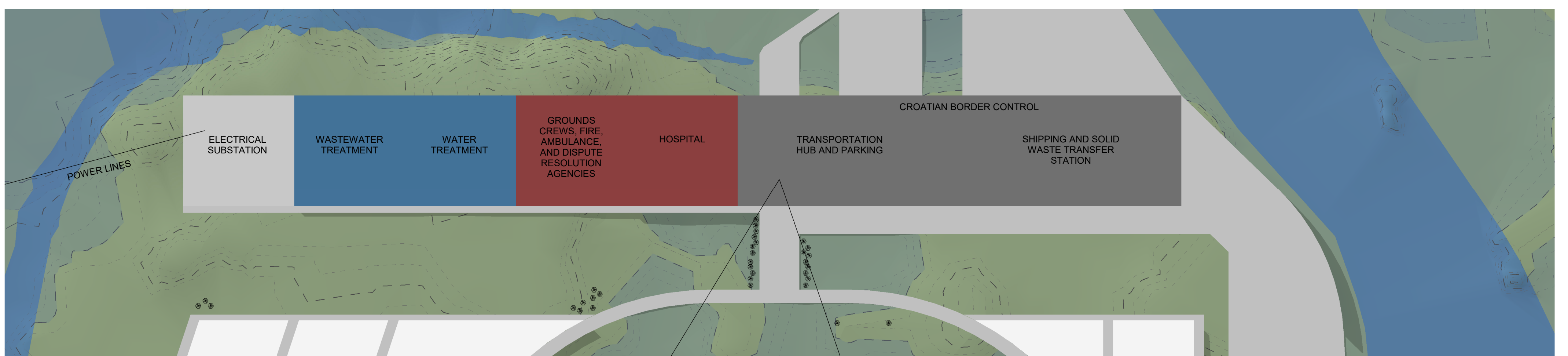


Image Source: Republic of Serbia, Republic Hydrometeorological Service of Serbia, Reporting surface water station: APATIN; May 13 2021; [http://www.hidmet.gov.rs/em/hidrologija/ovestajac/prognozaz.php?m\\_id=42015](http://www.hidmet.gov.rs/em/hidrologija/ovestajac/prognozaz.php?m_id=42015)



## WATER + WASTEWATER

### Water Treatment

If there's one thing Liberland has plenty of, it's water. Putting this water to good use requires a water treatment plant that draws from the Danube river, as many other communities along the Danube do. Alternatively, wells could be drilled to the large porous groundwater aquifer below Liberland.

120,000 Liberlanders will require up to 25 million litres of fresh water every day. In early stages, modular containerised water treatment plants can be used. As population increases, a larger permanent facility will be installed. This facility can be designed for multi-stage scalability.

Domestic water will be distributed via underground pipe systems. A water tower to pressurize the system located at the water treatment plant will be a visible landmark for travellers on the road from Croatia.

Most of the buildings in Liberland will be large enough to warrant installation of sprinkler systems. Local fire pumps will draw water from the mains system to supply sprinklers and hydrants.

### Wastewater Treatment

The John Maynard Keynes Sewage Treatment Plant (JMKSTP), named after an economist who was, like the treatment plant itself, full of crap, will break down organic matter in anaerobic digesters. The biogas produced from this process will be sent to the gas power station/cogeneration plant to produce electricity and heat. Treated wastewater will be returned to the river, using advanced technologies to minimize bioavailable nitrogen and phosphorus which can contribute to harmful eutrophication of the river, delta, and Black Sea beyond.

The facility will be located on high ground and be designed carefully to eliminate any risk of river contamination during flooding events. Where practical, open ponds and channels should be avoided, or should be safely above flood elevations.

In early stages, modular containerised sewage treatment plants can be used. As population increases, a larger permanent facility will be installed. This facility can be designed for multi-stage scalability.

The JMKSTP site is also the ideal location for the US and EU embassies in Liberland.

## SOLID WASTE

### Municipal Solid Waste (Landfill, Compost, & Recycling)

A landfill on Liberland would pose a significant environmental hazard to the Danube river ecosystem. Municipal solid waste will be collected at a transfer station to be trucked or shipped to a landfill or processing plant in a neighboring country.

The Schumpeter Waste Recovery Plant will produce compost and recycled materials to reduce exported waste. Compost can be used in landscaped areas to reduce or eliminate fertilizers which can harm the river ecosystem.

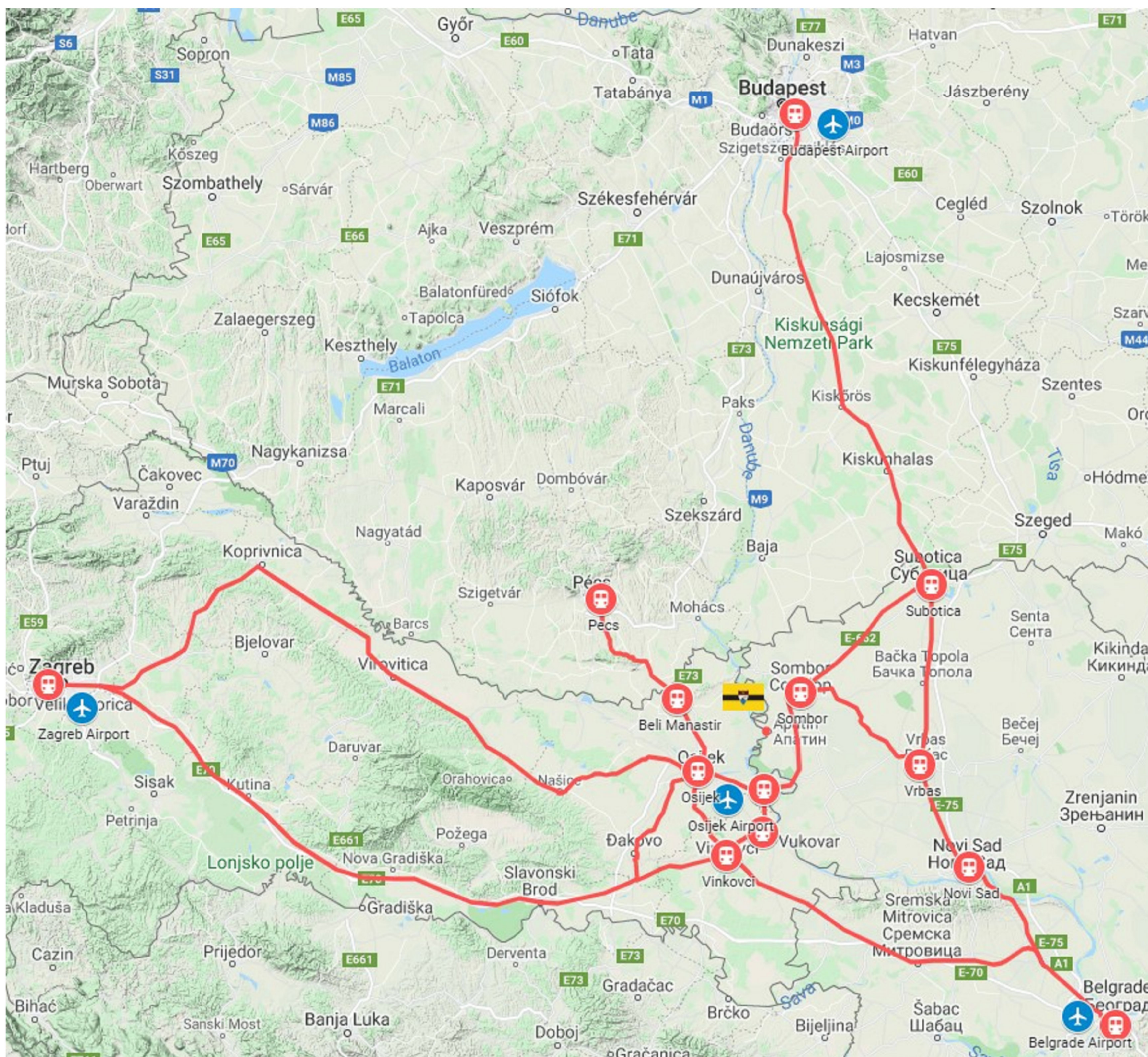
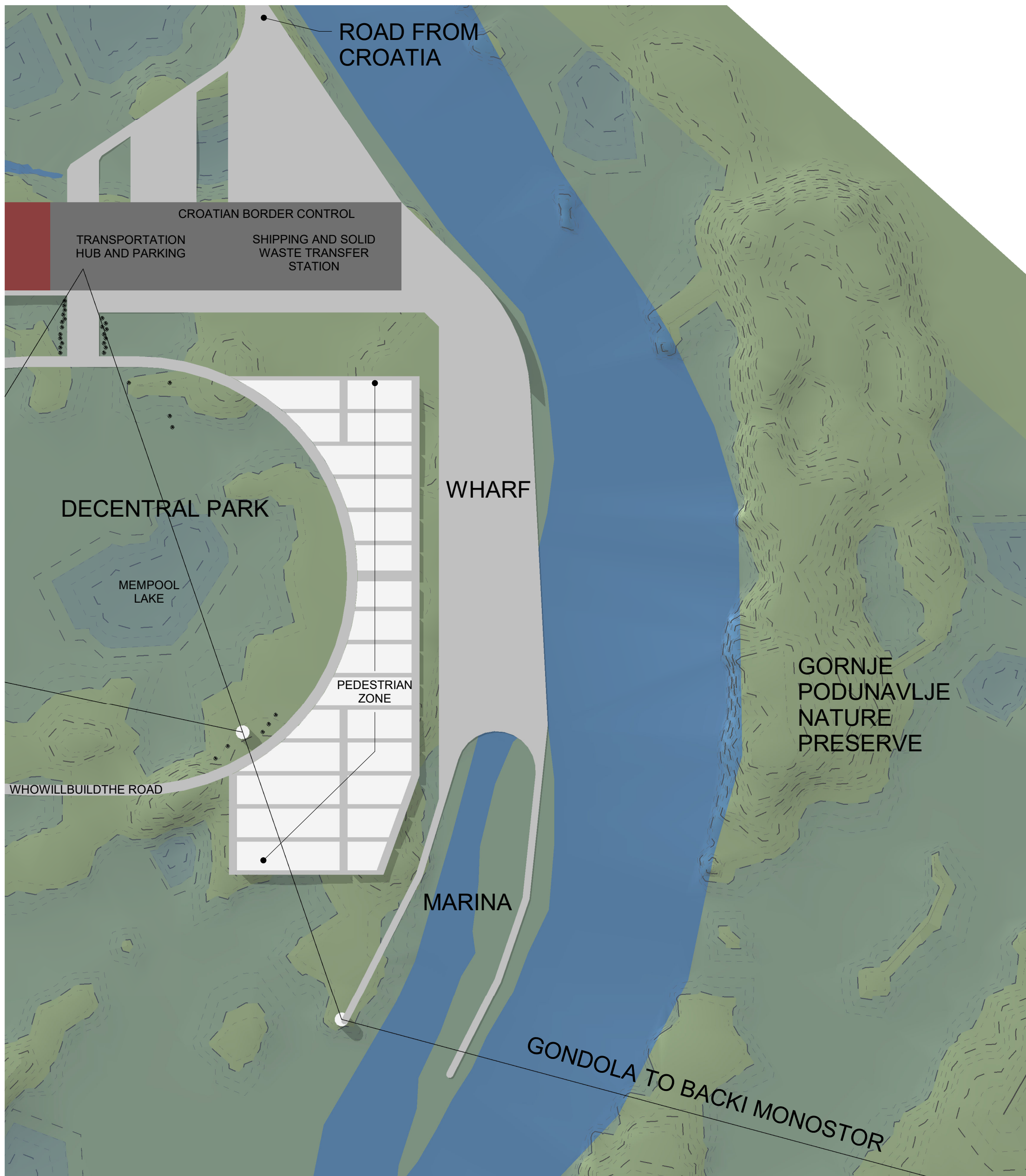
In addition, a pyrolysis/gasification system could process waste materials within Liberland. This system burns trash at high temperature in a low oxygen environment, producing "syngas" which can be burned in a boiler to produce heat or electricity.

While road traffic within the developed areas is limited, waste removal trucks will be able to access all buildings. Since waste removal will not be subsidized by taxes in Liberland, people will have an incentive to minimize their waste production.

If there is initially a municipal government in Liberland, it can rent temporary office space in the basement of the municipal waste facility until it is no longer needed.

# LIBERLAND

# TRANSPORTATION



Liberland's small footprint is a blessing in disguise for urbanism; it is inherently walkable, and cars simply won't fit. A variety of transport modes is available for local, regional, and international transportation.

## INTRACITY TRANSPORTATION

### Walking

On the rare occasion that a Liberlander takes a break from ranting on social media and leaves his home to experience the real world, he will probably walk there. The streets in developed areas are lively pedestrian thoroughfares. The lack of zoning means that ground level will be filled with shops, cafés, bars, restaurants and attractive plazas. Sidewalk entrepreneurs such as food trucks, pop-up vendors, street performers, and artists will make every trip to the corner store a unique experience. The furthest points of the developed areas can be traversed in around 30 minutes, making Liberland accessible to everyone.

### Vehicular Services

Whowillbuildthe Road around Decentral Park is designed for vehicular traffic, along with streets within developed areas. Vehicular access will be limited to emergency vehicles, maintenance and construction crews, deliveries, and waste removal trucks.

### Microtransit

For people in a hurry, microtransit options such as electric bikes and scooters will be readily available. The problems of microtransit, such as scooters and helmets littering sidewalks, are due to a tragedy of the commons under state ownership of public space. These concerns will be mitigated by owners of street and sidewalk space who require microtransit providers to respect other users of these spaces.

## REGIONAL TRANSPORTATION

### Riverboats and Barges

The Danube River's status as an international waterway creates the possibility of transportation and shipping into and out of Liberland without going through customs of any one bordering nation.

River barges, river cruise ships, and personal watercraft can access Liberland directly from many places in central Europe, from the North Sea to the Black Sea and beyond. However, river navigation may be slow due to locks up river and down river, as well as frequently changing depths and river bed conditions. The stretch of the river around Liberland is one of the most challenging to navigate. The navigable waterway has been maintained through dredging and is demarcated with signs and buoys. It is classified as Vlc Waterway Class, allowing for pushed convoys of as many as six 90m x 11m barges.

Passenger and freight wharves at Liberland and Apatin will serve multiple trips per day under normal conditions. During major flood events when regional roads may be inaccessible, riverboats from Apatin will continue to provide crucial supplies and passenger transport services.

### Personal Watercraft

A canalized marina protected from the river current will allow a large number of Liberlanders to dock personal watercraft for access to the series of canals around the region.

### Helicopter

Since every Liberlander will become fabulously wealthy, rooftop helipads will abound. Until then they can use the unnamed heliport on top of the transportation center. Helicopters can provide rapid transport to nearby cities such as Subotica, Novi Sad, or Belgrade.

### Airport

The Osijek Airport is 50km south of Liberland, with flights to Zagreb. With an additional 120,000 people in the area and frequent business travel, this airport could run more frequent flights. Belgrade Airport, 170km southeast of Apatin, is an international terminal with flights throughout Europe and the Middle East. The Sombor / Cora Military Airport may be usable for flights close to Liberland, if approved by the Serbian Military. It may be possible to utilize an airfield alongside the river to create direct access from an international terminal to a boat on the international water of the Danube without passing through border controls of another nation. Sportski Aerodrom Vukovar in Croatia, LHEC Airfield in Érsekcsanak Hungary, or a new airfield may accommodate this.

### Seaplane

Seaplanes carrying as many as 20 passengers could land on the river near Liberland with about 300m of runway and disembark in the marina, avoiding the need to pass through Serbian or Croatian border controls.

## EUROPEAN CYCLE ROUTE NETWORK



Image Source: EuroVelo, The European Cycle Route Network; European Cyclists Federation, Accessed May 13 2021. <https://en.eurovelo.com/>

### Cycling

The flat terrain makes Liberland ideal for cycling. Decentral Park features a network of walking and cycling paths as well as the ring road. Without car traffic, city streets have plenty of room for cyclists and pedestrians. The more adventurous cyclists can explore riding trails in the Tom Woods Woods nature preserve, or ride all the way to France on the existing EuroVelo 6 Danube Cycling Trail at Liberland's doorstep.

### Rideshare and Bus

While Liberlanders won't use cars within the city, ridesharing and bus services will provide fast and comfortable travel between the east and west developments.

## WATERWAY NETWORK

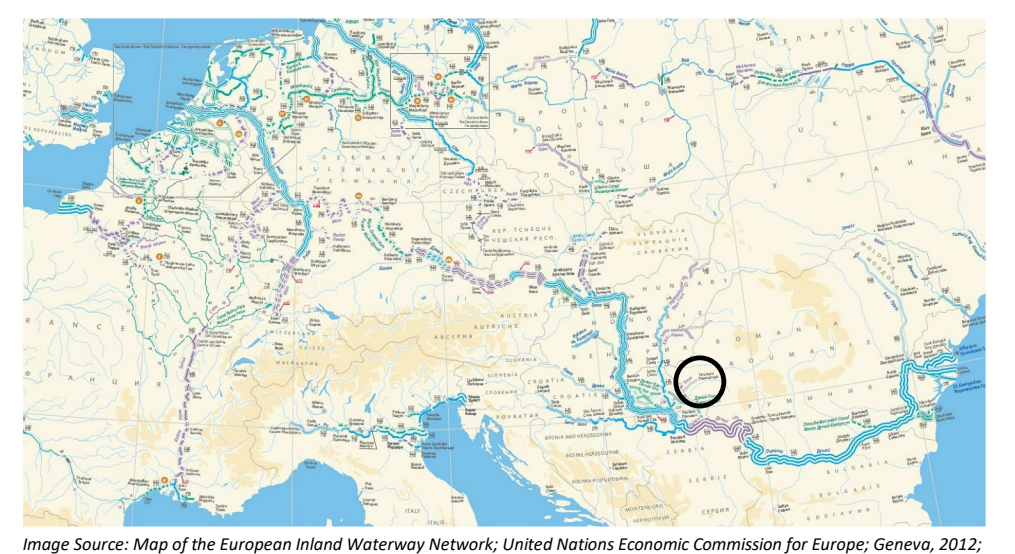


Image Source: Map of the European Inland Waterway Network; United Nations Economic Commission for Europe, Geneva, 2012. Production: EuroMapping www.euromapping.com

### Gondola

There may not be flying cars in Liberland (yet), but Gondolas are the next best thing. Stations at the Marina, Transport Hub, and West Development connect key points of interest for inbound visitors and Serbian commuters without passing through Croatian Border Control. A longer gondola route crossing the Danube could provide a slower but scenic route into the city, and would be an attraction for eco-tourists viewing the Gornje Podunavlje nature preserve. If the Sombor / Cora Airport is used, a gondola may be able to provide direct access from an international terminal to Liberland without passing through Serbian border control.

### Road

A road from Route 212 in Zmajevac, Croatia to Liberland's northern border is the main artery for freight and visitors. It may be possible to utilize the existing cycle path right of way. A transportation center will accommodate car parking, warehousing, and bureaucratic nonsense like Croatian customs and immigration control. An existing bridge crossing the Danube into Serbia is 10km north, providing a convenient route to Apatin and other neighboring Serbian towns. A bridge directly to Serbia is not anticipated due to the extents of the Gornje Podunavlje nature preserves across the river.

### Rail

Rail lines into Liberland are not practical or cost effective. Passengers and freight are better served by road from Croatia, and by river barges. However, for regional and international travel, Liberlanders can take a quick bus or rideshare to board a train at Beli Manastir, Croatia, or Sombor, Serbia. Osijek, Croatia is a prominent passenger hub with connections to Serbia, western and coastal Croatia, and beyond to Slovenia and Austria.

Category	Criterion	Personal Transport						Shared Transport						Freight Transport		
		Walking Paths	Cycling Paths	Micro-transit	Watercraft/ Marina	Helicopter/ Heliport	Car / Rideshare	Bus	Gondola	Rail	Riverboat	Seaplane	Airport	Road From Croatia	Rail	River Barge
Summary	Suitable for Liberland	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Yellow	Yellow	Green	Red	Green
Range	Internal Range	Yellow	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Yellow	Yellow	Green	Red	Green
	Regional Range	Red	Yellow	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green
	International Range	Red	Red	Red	Red	Red	Yellow	Yellow	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green
	Speed / Travel Time	Red	Green	Green	Green	Green	Yellow	Green	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green
Cost	Passenger Experience	Green	Green	Green	Green	Green	Yellow	Green	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green
	Initial Capital Cost	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Fuel / Electricity Cost	Green	Green	Green	Green	Yellow	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red
	Equipment Maintenance Cost	Green	Green	Green	Green	Yellow	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red
Infrastructure	Levelized Cost per km	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Yellow	Green	Green	Yellow	Green	Yellow	Green
	Redundancy	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Incremental Installation	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Future Expandability	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
Land	Decentralized Ownership	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Internal Footprint	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	External Easements	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Existing Infrastructure	Red	Yellow	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green	Yellow	Green	Yellow	Green	Green
Safety & Environment	Avoid River / Wetlands	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Risk of Injury or Property Damage	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Noise	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Emissions	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Risk of Spills	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
Political	Habitat Impact	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	End of Life Disposal / Rehab.	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green
	Imported Fuel Source	Green	Green	Yellow	Red	Red	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red
	International Border Crossing	Green	Green	Yellow	Red	Red	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red
Political	Resiliency Disasters, War, etc)	Green	Green	Green	Green	Yellow	Red	Green	Yellow	Red	Green	Green	Red	Red	Red	Green

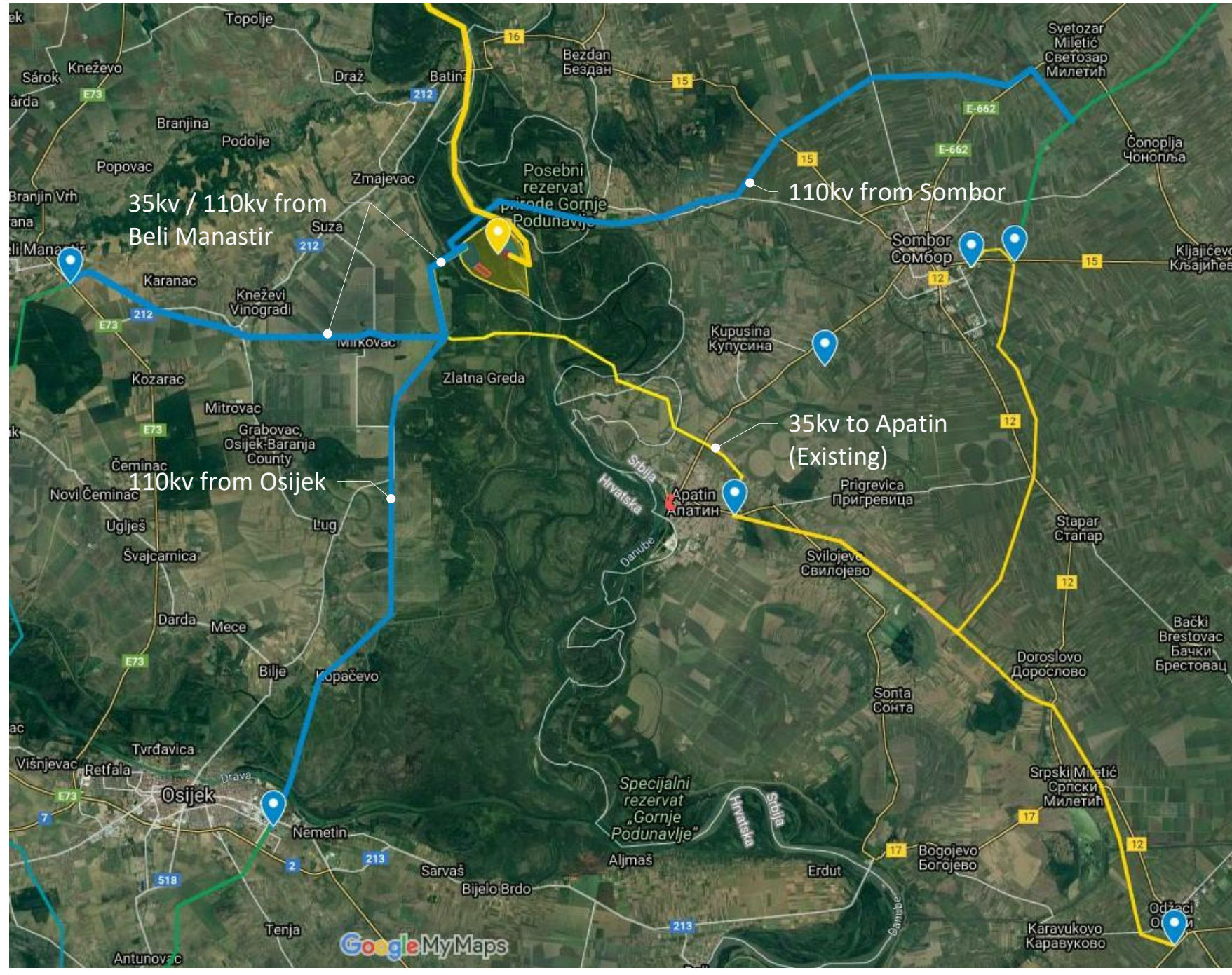
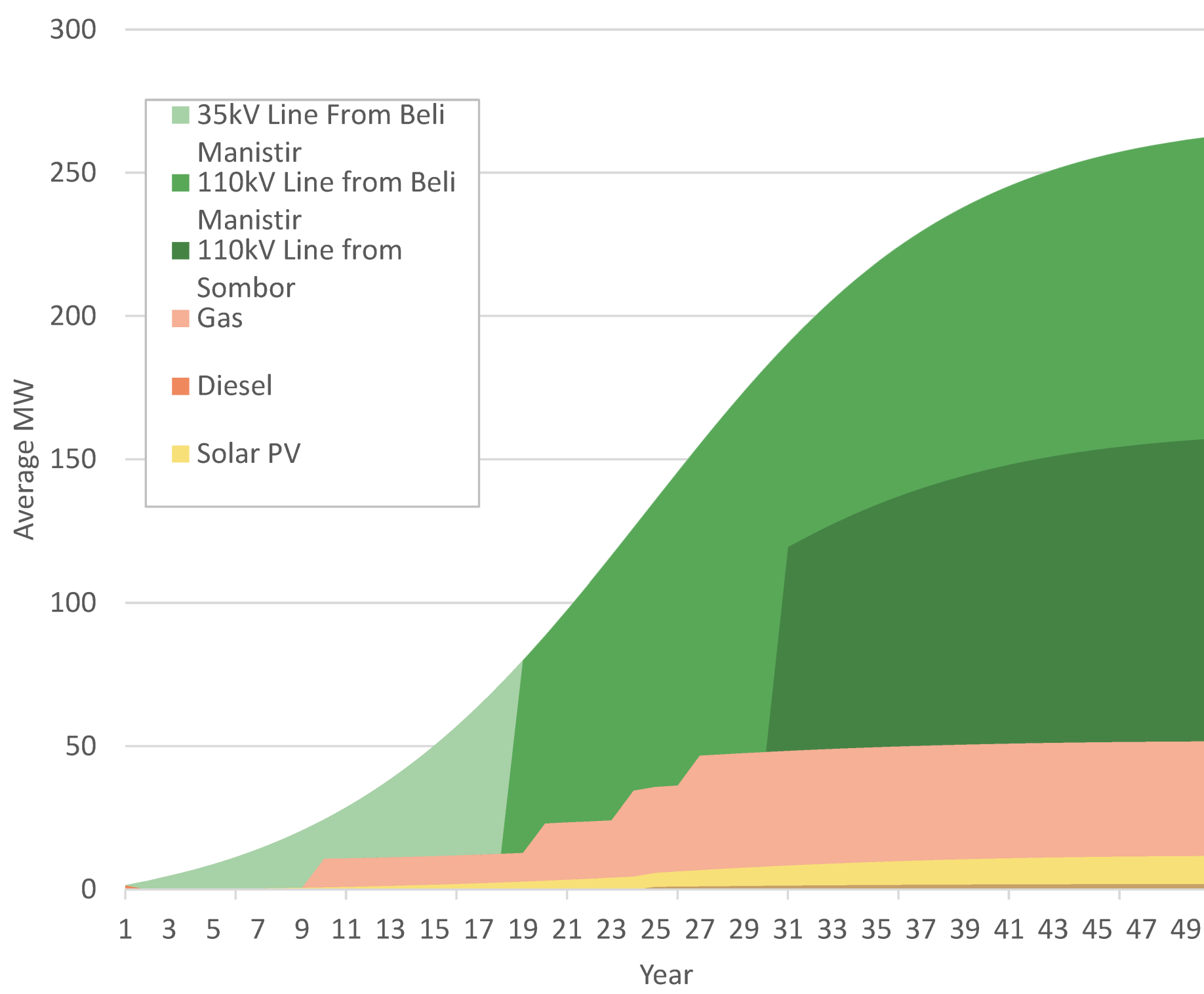


Image Source: Google My Maps, Accessed May 13 2021, <https://www.google.com/maps>

Energy Mix: Power Supply by Source Over 50 Years



Note: Energy intensive industries such as datacenters and blockchain mining farms would further increase this demand.

## POWER

Liberland's power demand is projected to increase from less than 1MW during initial construction to over 250MW at 120,000 people. A variety of power generation options are available, but not all of them are suitable for Liberland. The limited land area, especially considering the flood risk, makes large power stations impractical.

Grid connections from Croatia and Serbia will provide stable and flexible power. This can be supplemented by some local gas and solar power generation. Other technologies, like wind and hydroelectric, are ruled out by the lack of appropriate environmental conditions.

### Grid Connection

Europe has the largest synchronous electrical grid in the world, with Croatia, Serbia, and Hungary among the most interconnected nations within that grid. An external grid connection provides stable and flexible power to match Liberland's changing power demands. It requires a very small footprint for a receiving substation, and is a long lasting, low maintenance asset.

While Europe's grid has the risk of increasing instability as more solar and wind are brought online, its operation by an international consortium of power generators reduces the risk of any one nation cutting the cord to Liberland for political whims. The risk of disruption can be further reduced by installing overhead lines to both the Croatian and Serbian grids. Each of these lines can be designed for 100% of the required peak capacity.

A 35kV line runs from Beli Manastir to Apatin, crossing the Danube river just south of Liberland. A 5km line as shown could supply all of Liberland's power needs in the early stages.

As demand increases, a 110kV line can be installed from Beli Manastir to Liberland along the existing 35kV route (23km length). To connect to Serbia, a 110kV line can be installed from Sombor along the 33km route shown.

### Diesel Generation

Diesel generators will be necessary for the earliest stages of construction until grid power is connected. Diesel will have a long term role as backup power for essential services. Small generators can be installed in buildings and sized for each building's needs. Large scale base load diesel generation is not suitable due to fuel cost, maintenance cost, and emissions.

### Gas Generation

A gas power station could provide a significant portion of Liberland's power and reduce grid dependency. Gas power generation is cost effective, proven, flexible, and relatively clean. Generators can be installed in a central power station or decentralized in individual buildings or districts. Installation can be staged, with additional capacity added as the city grows.

Combined Heat and Power, or Cogeneration, can distribute waste heat from the engines to heat buildings, achieving over 90% total efficiency from the gas consumed. This will place additional demand on the incoming pipeline, but 40-50% of this additional demand will be offset by the heat produced using cogeneration.

### Biogas Generation

Modern wastewater treatment plants use anaerobic digestion to break down organic matter into biogas comprised of methane and carbon dioxide. The biogas is burned in an engine to generate power and destroy the methane and other harmful substances. Heat from the engines is recovered and used to warm the digesters.

A population of 120,000 people could produce enough biogas for around 2MW of power. This power would be consumed by the treatment plant, reducing its energy costs and reliance on grid power.

### Nuclear Generation

Every libertarian wants to have their own "Recreational Nukes." Now they can, since the power station is named "Recreational Nuclear Power Plant."

Nuclear power generation provides carbon free base load power in a compact footprint. Modern nuclear power technology is safe and reliable. The Paks Nuclear Power Plant is 120 km North in Hungary, which implies that there is an established fuel supply and waste disposal route nearby, as well as nearby technical expertise. Onsite fuel storage reduces the risk of disruption due to external grid or gas pipeline failures. Prepackaged small scale "micro-nuclear" generators can be installed incrementally.

However, political risks and international regulations may make this solution impractical.

### Solar Photovoltaic Generation

Covering the entire 7 km<sup>2</sup> land area with solar panels would produce a peak output of 1,400 MW, and annual average of 200 MW. This is sufficient for the projected power demand, however Liberland would just be one big solar farm. Since most of Liberland regularly floods, a large scale solar farm is not practical. Access to sunlight should be prioritized for vegetation and daylighting buildings and public places.

A free city should be able to produce more value from its land than a few kilowatts per square meter. A small amount of rooftop solar panels could be installed on the taller buildings. Smaller buildings could be shaded by larger ones, which reduces the usable roof space. With panels on 25% of the designed roof area, 70MW peak / 10MW average capacity could be installed.

### Wind Turbine Generation

What wind? With average wind speeds of 1-2m/s, wind in Liberland is almost non-existent. An average wind speed of 6m/s is required for a viable wind farm. Even if there were wind, the footprint required for a wind farm is enormous. Liberland's 7km<sup>2</sup> area could support around 25MW (peak) of wind turbines. Wind power could be more viable if developed offsite in neighboring countries in more suitable locations connected to the grid.

### Geothermal Generation

Geothermal technology uses the earth's inner heat to produce steam which can drive a turbine and generate reliable base load electricity with zero emissions. Wells are drilled into "hot rocks" hundreds of meters deep. The rock is fractured to allow water to pass through.

Water is injected into one well where it passes through the hot rocks, evaporating into steam. The steam is recovered via another well and passes through a turbine, generating electricity. Steam is condensed back to water and re-injected into the well.

The viability of geothermal power depends on the local geology and available heat. There is a high initial investment but zero fuel cost and zero emissions. Several exploration projects are currently in progress in neighboring regions. If these are successful, then geothermal power could be an opportunity for Liberland.

### Hydroelectricity

When there is so much water that the entire country floods every year, hydroelectric generation seems like an obvious choice. However, a hydroelectric turbine requires a pressure differential to force water through the turbine blades. The Danube river adjacent to Liberland is almost perfectly flat, meaning that very little energy can be extracted from it. A large waterwheel on the river might be an interesting design feature, but it wouldn't be much more than that.

### Battery Energy Storage System (BESS)

The grid penetration of intermittent sources such as solar and wind is making grids less stable. Battery Energy Storage Systems (BESS) are not generators. They absorb excess power from the grid during periods of low demand, and export power back to the grid when demand increases. This improves grid stability and can also provide uninterrupted short term backup power in the event of a grid failure.

BESS technology will likely have a place in Liberland, especially as the battery costs continue to reduce. It will be most useful in decentralized, small scale installation in individual buildings.

Category	Criterion	Grid Import Transmission Lines	Non-Renewable Generation			Renewable Generation				Storage Battery (BESS)
			Diesel	Natural Gas	Nuclear	Biogas	Solar Panels	Wind Turbine	Hydroelectric	
Summary	Suitable for Liberland	●	●	●	●	●	●	●	●	●
Capacity	Capacity (MW)	●	●	●	●	●	●	●	●	●
	Annual Generation (MWh/year)	●	●	●	●	●	●	●	●	●
	Reliable Base Load / Intermittency	●	●	●	●	●	●	●	●	●
	Flexible Peaking / Variable Loads	●	●	●	●	●	●	●	●	●
	Short term / Temporary Power	●	●	●	●	●	●	●	●	●
	Emergency Backup Power	●	●	●	●	●	●	●	●	●
	Combined Heat & Power Cogeneration	●	●	●	●	●	●	●	●	●
Infrastructure	Redundancy	●	●	●	●	●	●	●	●	●
	Incremental Installation	●	●	●	●	●	●	●	●	●
	Future Expandability	●	●	●	●	●	●	●	●	●
	Equipment Lifespan	●	●	●	●	●	●	●	●	●
Cost	Decentralized	●	●	●	●	●	●	●	●	●
	Initial Capital Cost	●	●	●	●	●	●	●	●	●
	Fuel / Import Tariff Cost	●	●	●	●	●	●	●	●	●
	Equipment Maintenance Cost	●	●	●	●	●	●	●	●	●
Land	Levelized Cost of Energy (\$/MWh)	●	●	●	●	●	●	●	●	●
	Internal Footprint	●	●	●	●	●	●	●	●	●
	External Easements	●	●	●	●	●	●	●	●	●
Safety & Environment	Avoid River / Wetlands	●	●	●	●	●	●	●	●	●
	Renewable Energy Source	●	●	●	●	●	●	●	●	●
	Noise	●	●	●	●	●	●	●	●	●
	Emissions	●	●	●	●	●	●	●	●	●
	Risk of Spills	●	●	●	●	●	●	●	●	●
Political	End of Life Disposal / Rehabilitation	●	●	●	●	●	●	●	●	●
	External Generation	●	●	●	●	●	●	●	●	●
	Imported Fuel Source	●	●	●	●	●	●	●	●	●
	International Regulations	●	●	●	●	●	●	●	●	●
	Resiliency (Natural Disasters, War, etc)	●	●	●	●	●	●	●	●	●

## HEATING AND COOLING

Liberland's ambient temperature ranges from -5°C to over 35°C. It will require an average of up to 200MW of heating energy with a peak demand of 700MW.

### Gas Heating

There is an existing 50bar gas pipeline at Beli Manastir, Croatia, 23km away. A 200mm diameter pipeline spur could supply all of Liberland's heating and gas power generation. Gas is also available at Sombor, Serbia, but this pipeline would need to be installed below the Danube river bed. Gas can be reticulated to individual buildings for heating, cooking, and hot water service.

### District Hot and Chilled Water

A central heating plant can reduce the footprint required for boilers in the developed areas. Hot water or steam pipework is distributed to buildings and can be stored to smooth out demand peaks. This can be paired with recovered waste heat from the power station (Cogeneration).

A central chiller plant can circulate a chilled water piping loop to buildings to reduce the size and energy use of building-mounted chillers. Waste heat can be recovered for the central heating plant.

### Electric Heating and Cooling

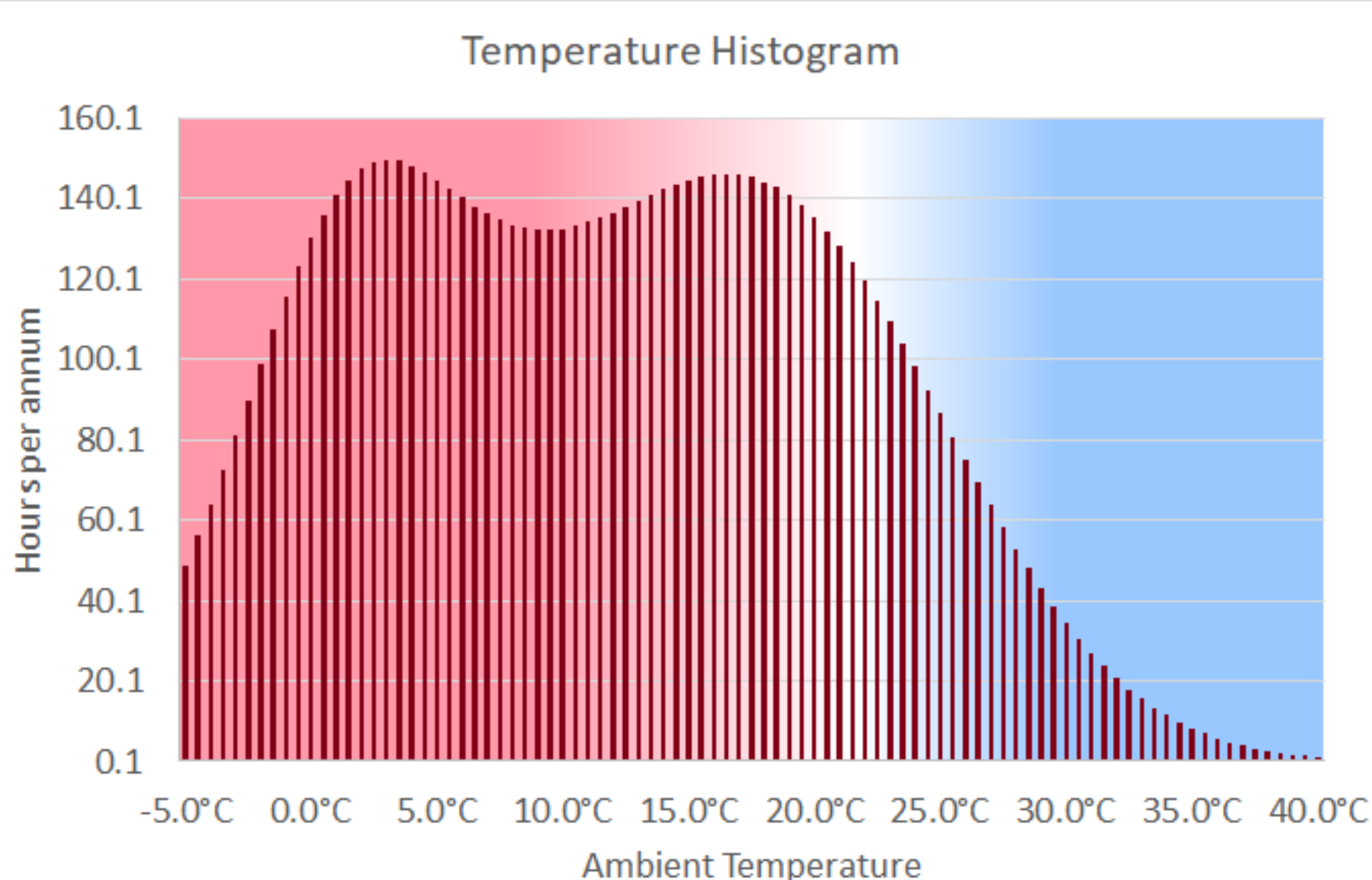
Reversible Heat Pumps can provide both heating and cooling at high efficiency, while reducing the space required for separate heating and cooling systems. They can be installed on individual buildings for a decentralized and incremental solution.

Air Cooled Chillers produce chilled water using a refrigeration process which rejects heat to ambient air. While these are efficient, they require space for water to air heat exchangers and fans and can be noisy.

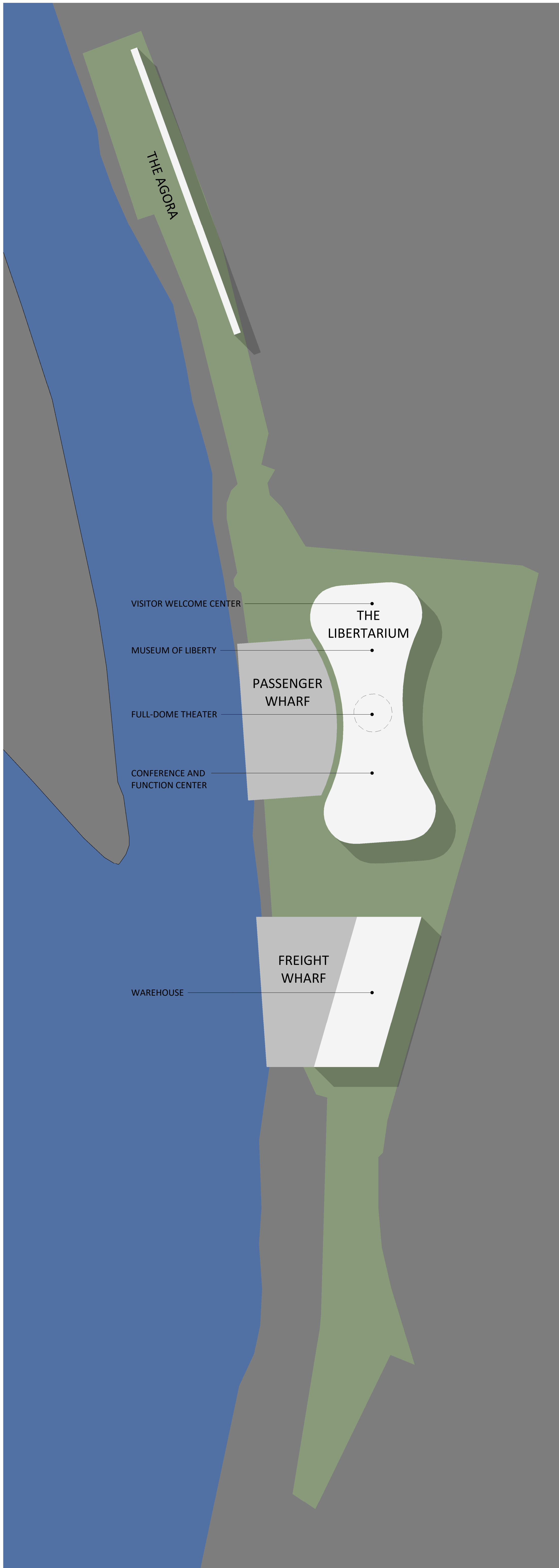
Water Cooled Chillers could mitigate some of the noise and space requirements, since they don't require large fans. These would draw water from the Danube river through a series of large heat exchangers which transfer heat from the chiller to the river water. This could be problematic for the ecology if the returning water temperature is too high.

### Geothermal Heating and Cooling

While geothermal power generation is complex and uncertain, geothermal wells for heating and cooling are a much more proven technology. Water is pumped down a U-shaped pipe 500ft below ground and is warmed or cooled by the earth's naturally moderate temperature. However, the capacity of each well is limited, making this impractical for Liberland.



Category	Criterion	Heating				Cooling			Combined Heating/Cooling	
		Diesel / Fuel Oil	Natural Gas	Central Heating Plant (Gas)	Biogas Cogeneration	Natural Gas Cogeneration	Natural Ventilation	River Water Cooling	Electric Heat Pumps / Air Conditioning	Geothermal Ground Loops
Summary	Suitable for Liberland	●	●	●	●	●	●	●	●	●
Capacity	Capacity (MW)	●	●	●	●	●	●	●	●	●
	Annual Production (MWh/year)	●	●	●	●	●	●	●	●	●
Infrastructure	Redundancy	●	●	●	●	●	●	●	●	●
	Incremental Installation	●	●	●	●	●	●	●	●	●
	Future Expandability	●	●	●	●	●	●	●	●	●
	Equipment Lifespan	●	●	●	●	●	●	●	●	●
Cost	Decentralized	●	●	●	●	●	●	●	●	●
	Initial Capital Cost	●	●	●	●	●	●	●	●	●
	Fuel / Import Tariff Cost	●	●	●	●	●	●	●	●	●
	Equipment Maintenance Cost	●	●	●	●	●	●	●	●	●
Land	Levelized Cost of Energy (\$/MWh)	●	●	●	●	●	●	●	●	●
	Internal Footprint	●	●	●	●	●	●	●	●	●
	External Easements	●	●	●	●	●	●	●	●	●
Safety & Environment	Avoid River / Wetlands	●	●	●	●	●	●	●	●	●
	Renewable Energy Source	●	●	●	●	●	●	●	●	●
	Noise	●	●	●	●	●	●	●	●	●
	Emissions	●	●	●	●	●	●	●	●	●
	Risk of Spills	●	●	●	●	●	●	●	●	●
Political	End of Life Disposal / Rehab	●	●	●	●	●	●	●	●	●
	External Generation	●	●	●	●	●	●	●	●	●
	Imported Fuel Source	●	●	●	●	●	●	●	●	●
	International Regulations	●	●	●	●	●	●	●	●	●
Resiliency (Disasters, War, etc)	Resiliency (Disasters, War, etc)	●	●	●	●	●	●	●	●	●



Napredak is the gateway to Liberland and a destination in itself, both for Liberlanders and foreign visitors. Open plazas and a riverside esplanade make it a flexible space for hosting a wide variety of events.

Features include:

- The Libertarium, an iconic multifunctional building, is the main attraction.
- The Agora, an open air marketplace along the banks of the Danube
- Passenger Wharf
- Freight Wharf and Warehouse Facility

## THE LIBERTARIUM

The Libertarium is a beacon of liberty to attract and welcome visitors from all over the world.

This landmark building serves multiple functions:

- Museum of Liberty
- Full-dome theater
- Conference and function center
- Visitor Welcome Center

### Museum of Liberty

The Libertarium features an array of exhibits to educate visitors about the philosophy and history of human freedom.

Exhibits:

- Historical Timeline showcasing prominent thinkers and historical events
- Interactive exhibit where visitors can interact with each other in an ongoing "sim city" style game. Highlight entrepreneurship vs central planning
- Interactive map showing freedom index and economic development metrics for different countries
- Exhibits explaining blockchain technology
- Liberland development history and relationship with the surrounding ecology

### Full-dome Theater

The full-dome theater is the centerpiece of the Libertarium. Using video projection technology common in modern planetarium theaters, it allows immersive group visualization of virtual spaces.

Visuals:

- Fly-through of Liberland showing evolution through various stages
- Real time immersive visualization of architectural models and virtual spaces
- Full-dome video plus Augmented Reality for a richer immersive experience
- Planetarium, stargazing, and entertainment shows
- Large format cinema
- Unique presentation/event space

### Conference and Function Center

The building is designed for modular internal space configurations. Spaces that aren't used for museum exhibits can host functions and conferences.

The Full-dome theater also provides a unique space for presentations, cocktail parties, and other events.

This is potentially the primary revenue center for the facility. It also gives diverse groups of professionals and other people a reason to visit Liberland.

### Visitor Welcome Center

Liberland is a destination for tourists and business travellers. A welcome center in The Libertarium will offer information about getting into and around Liberland.

Visitors can book ferry rides and guided tours here.

## OTHER NAPREDAK FEATURES

### The Agora

A designated area with pop-up markets for local craftsmen and farm produce, bringing together Liberlanders and natives from the surrounding region.

The Agora is an ongoing demonstration of libertarian principles and markets in action.

### Passenger Wharf

Visitors to Liberland can embark here after exploring Napredak.

### Freight Wharf and Warehouse

While most freight to Liberland will be delivered via the road from Croatia, this facility opens a second channel for delivery of goods by river barge.

### Floating Man Festival

Some key features of The Libertarium and Agora can be showcased at the Floating Man Festival, in a "pop-up Libertarium" format.

The footprint of the proposed building can be marked on the ground and with temporary structures to emulate a skeleton of the ultimate building shape.

A temporary inflatable dome and projection system can give Floaters the first views of Liberland's future. Flythroughs of various proposed 3D models of the city can be shown to build excitement and spark new ideas for how the city will look and function.

Other festival stalls and event spaces can be located within the Libertarium, foreshadowing the future locations of exhibits, conference stalls, and function spaces. This will provide real world insight into space allocation and traffic flows in the ultimate building design.