Zengwen/Nanhua Interconnecting Pipeline Project

Southern Region Water Resources Office, WRA, MOEA

10-day Water Outage

due to an Earthquake in 2016

Tainan Cty
in Feb. 2016

6-month Water Rationing

The rainfall from August **2014 to** March **2015** was at an all-time-low since records began in 1947.

Nanhua Reservoir
in April, 2015

Outline

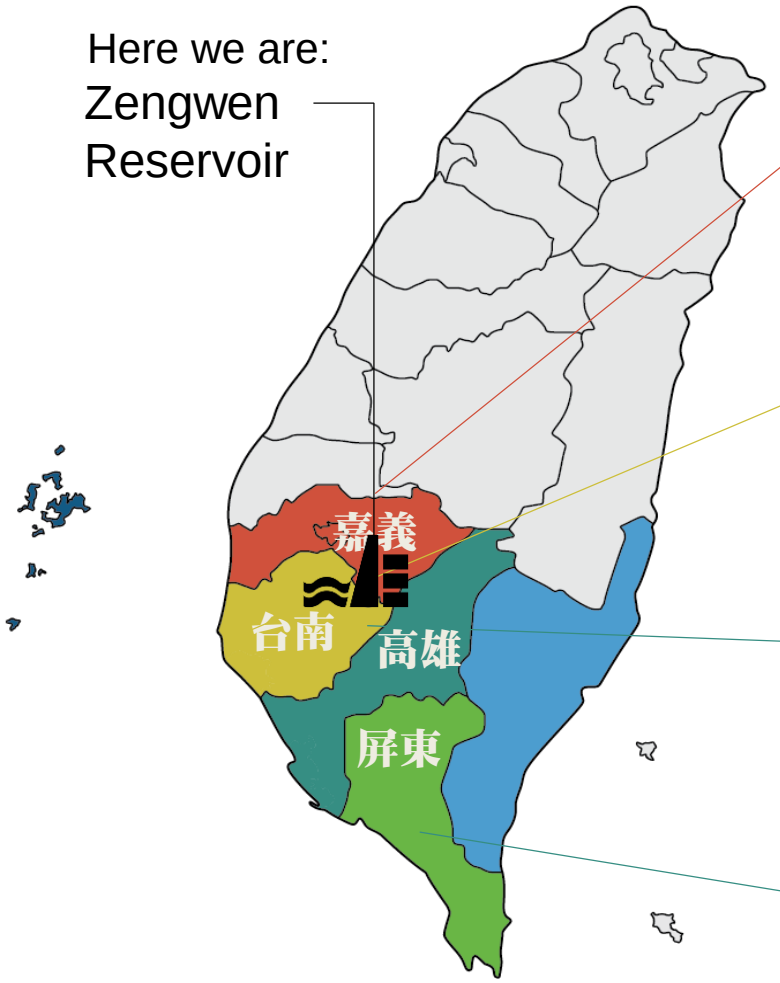
1. Water Usage Issues in Southern Taiwan
2. Main Content of the Pipeline Project
3. 3 Crucial Issues in the Left Abutment of the Dam & Our Assessment

1 Water Usage Issues

in Southern Taiwan

Water Use in Southern Taiwan

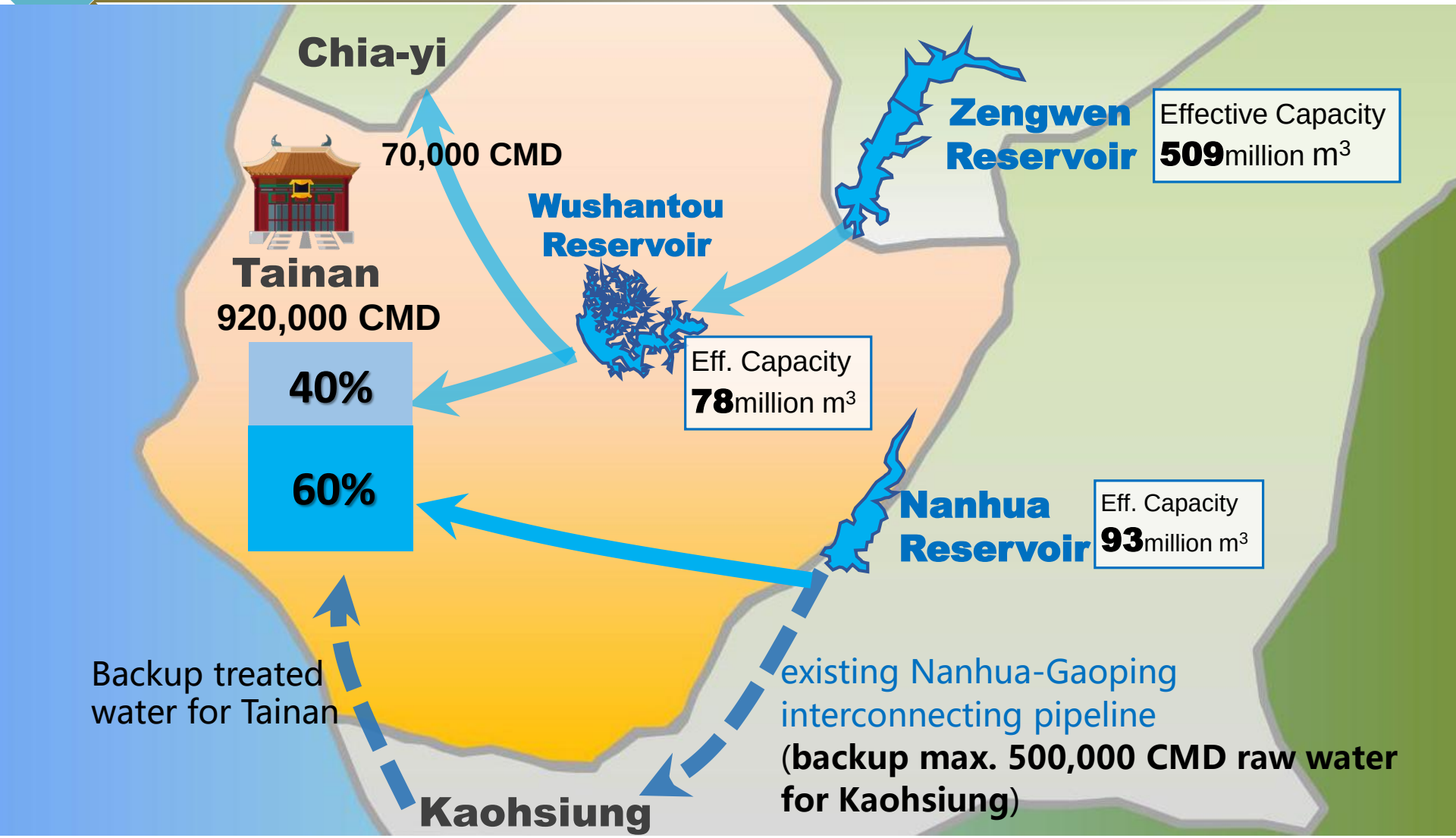
Here we are:
Zengwen Reservoir



Domestic & Industrial Water Usage (tons/day)

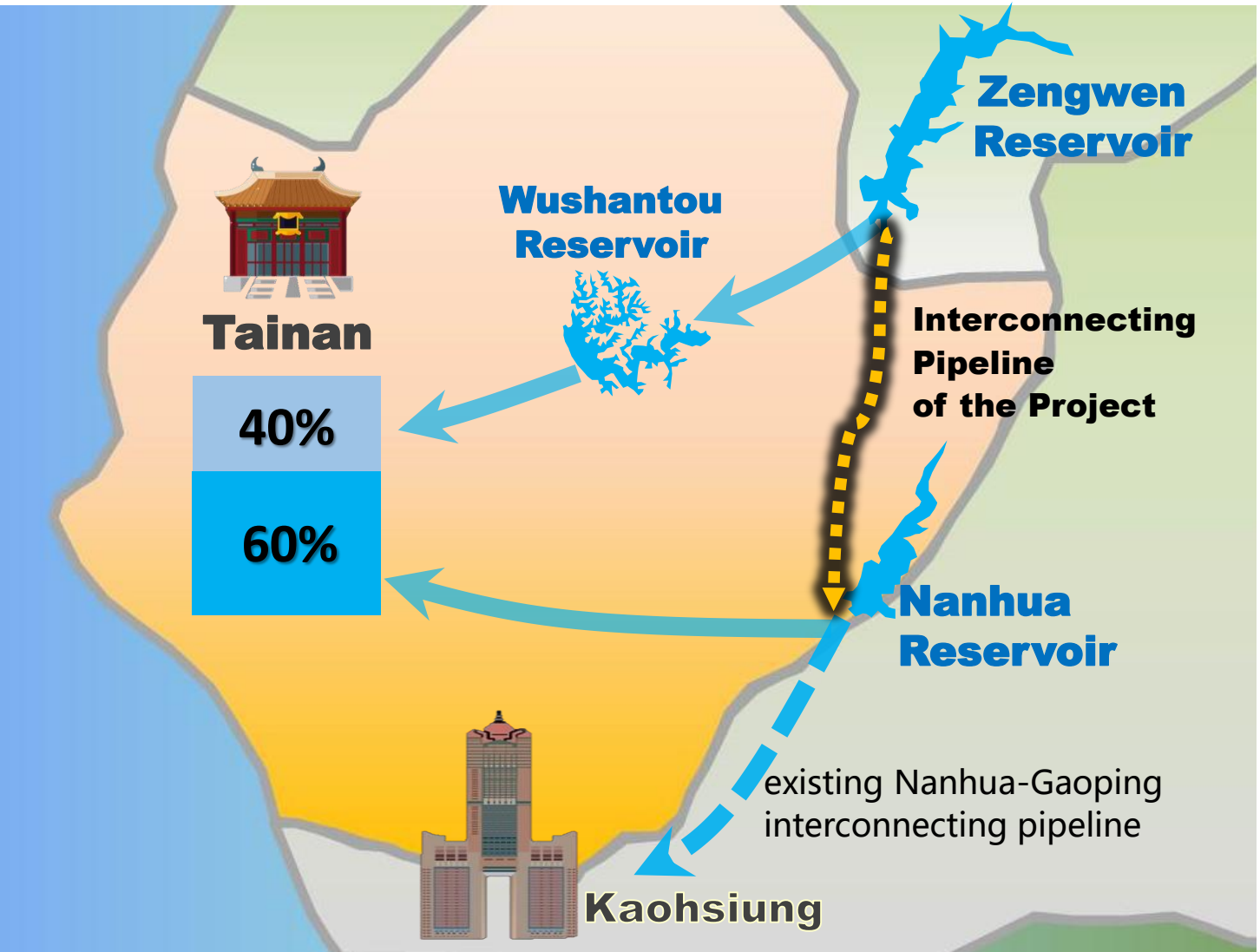
Chia-yi County	280,000
Tainan City	920,000
Kaohsiung City	1,600,000
Pingtung County	160,000

Current Situation of Water Supply



Water Supply Issues~

1. NO raw water backup pipelines



Drought Event

(22nd Apr. 2015)

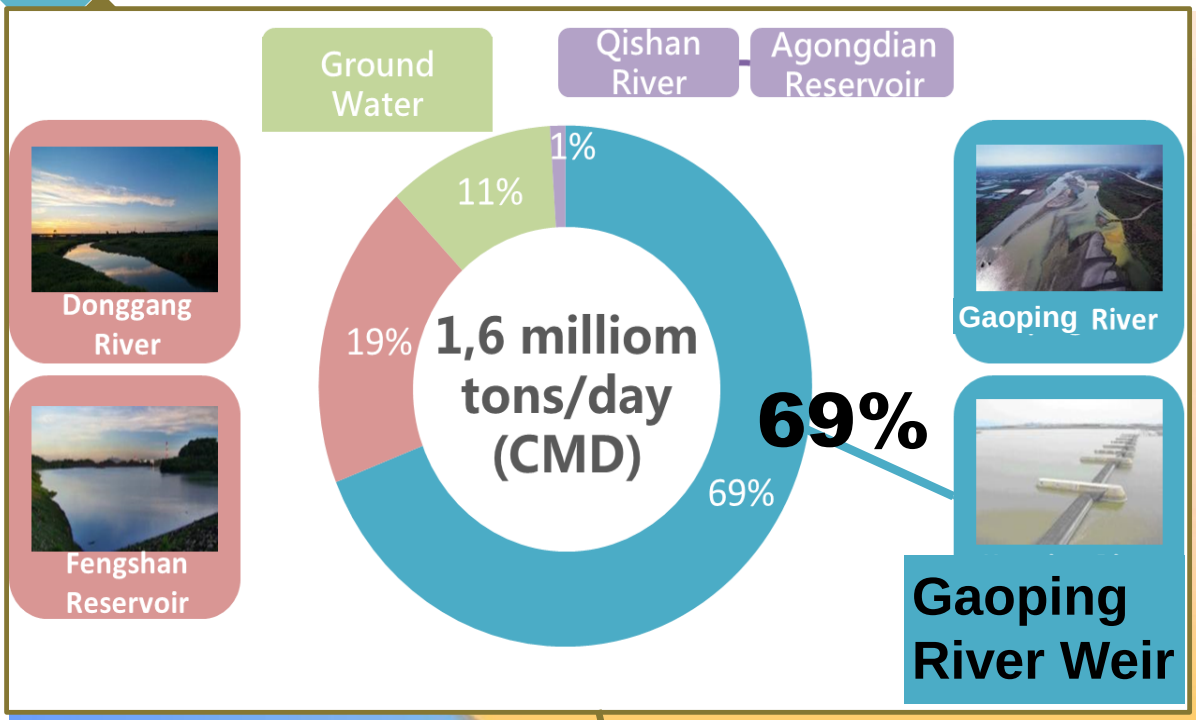
132 million tons

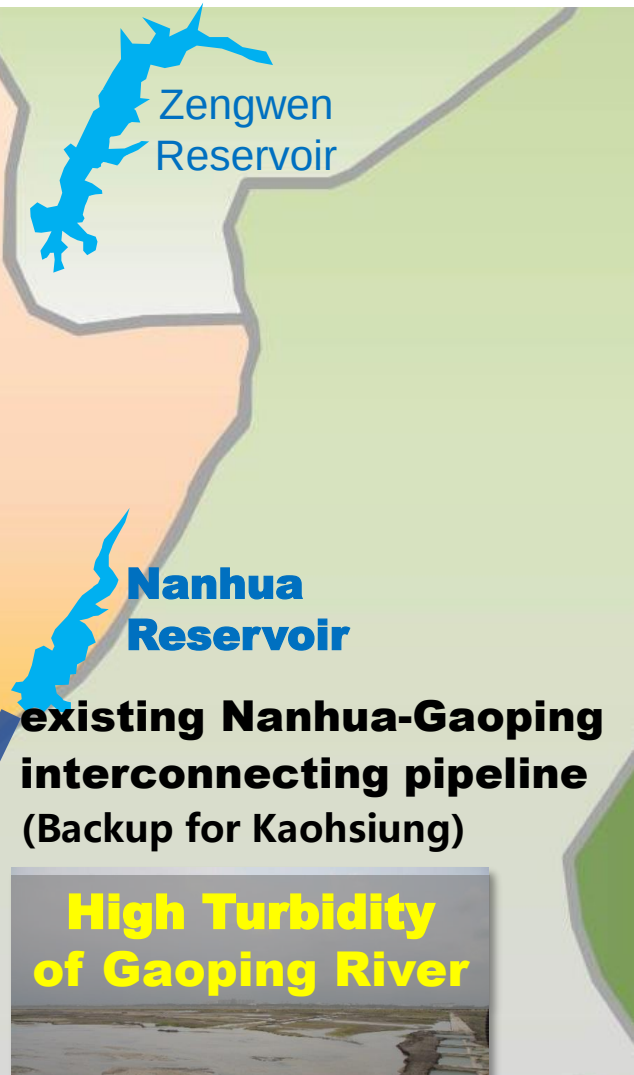
Zengwen + Wushantou

21 million

Nanhua

2. Water Supply Issues in Kaohsiung City





3. Pressure of water supply in Nanhua Reservoir

Capacity is less, but load is heavier.

Nanhua Reservoir

= 17% ×

Tsengwen Reservoir

+

Wushantou Reservoir

Zengwen Reservoir

Wushantou Reservoir

40%

60%

Tainan

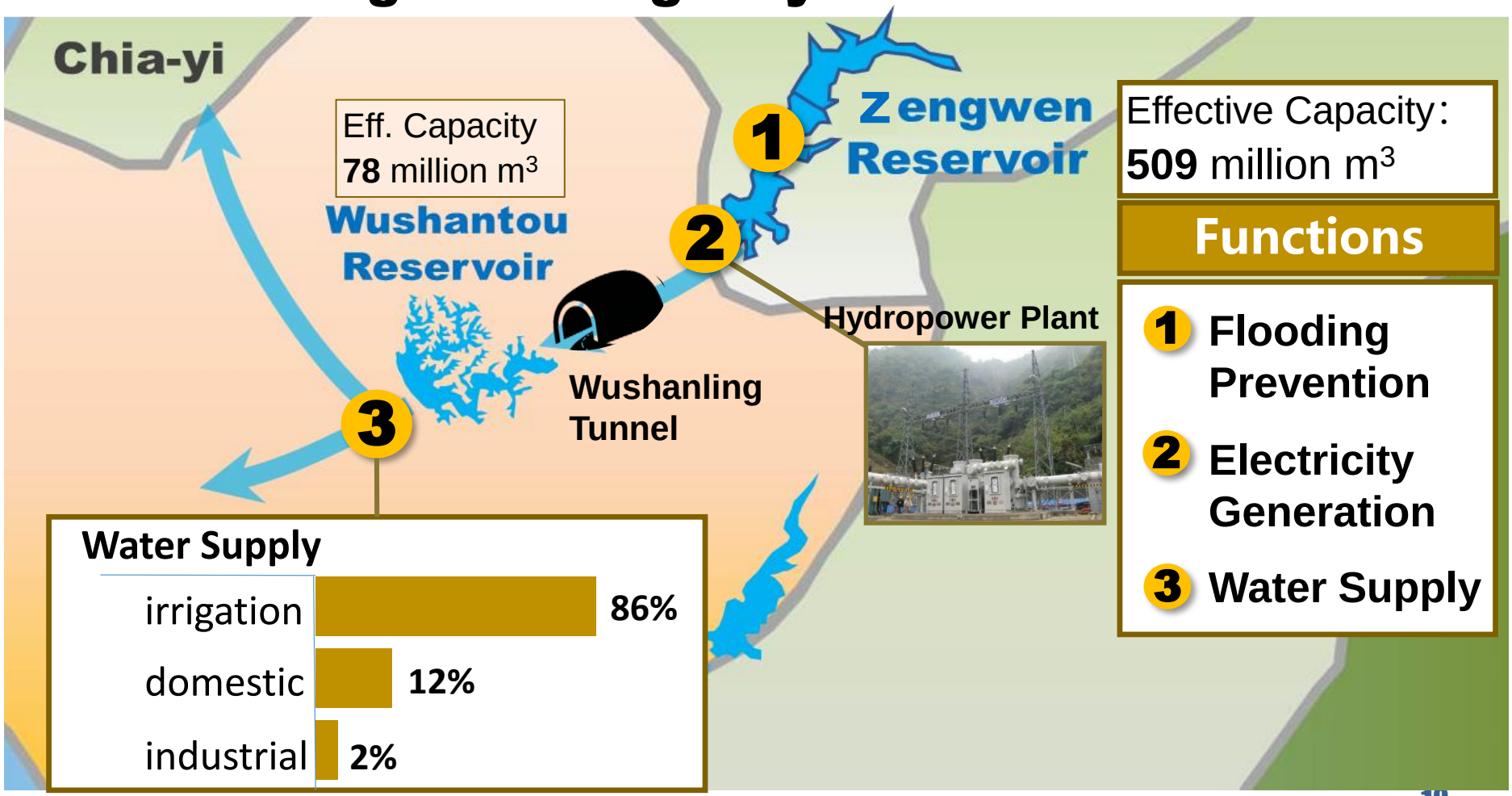
Nanhua Reservoir

Backup for Kaohsiung when necessary

Kaohsiung

4. Only one route can supply water.

Water won't be able to be sent out during an emergency.

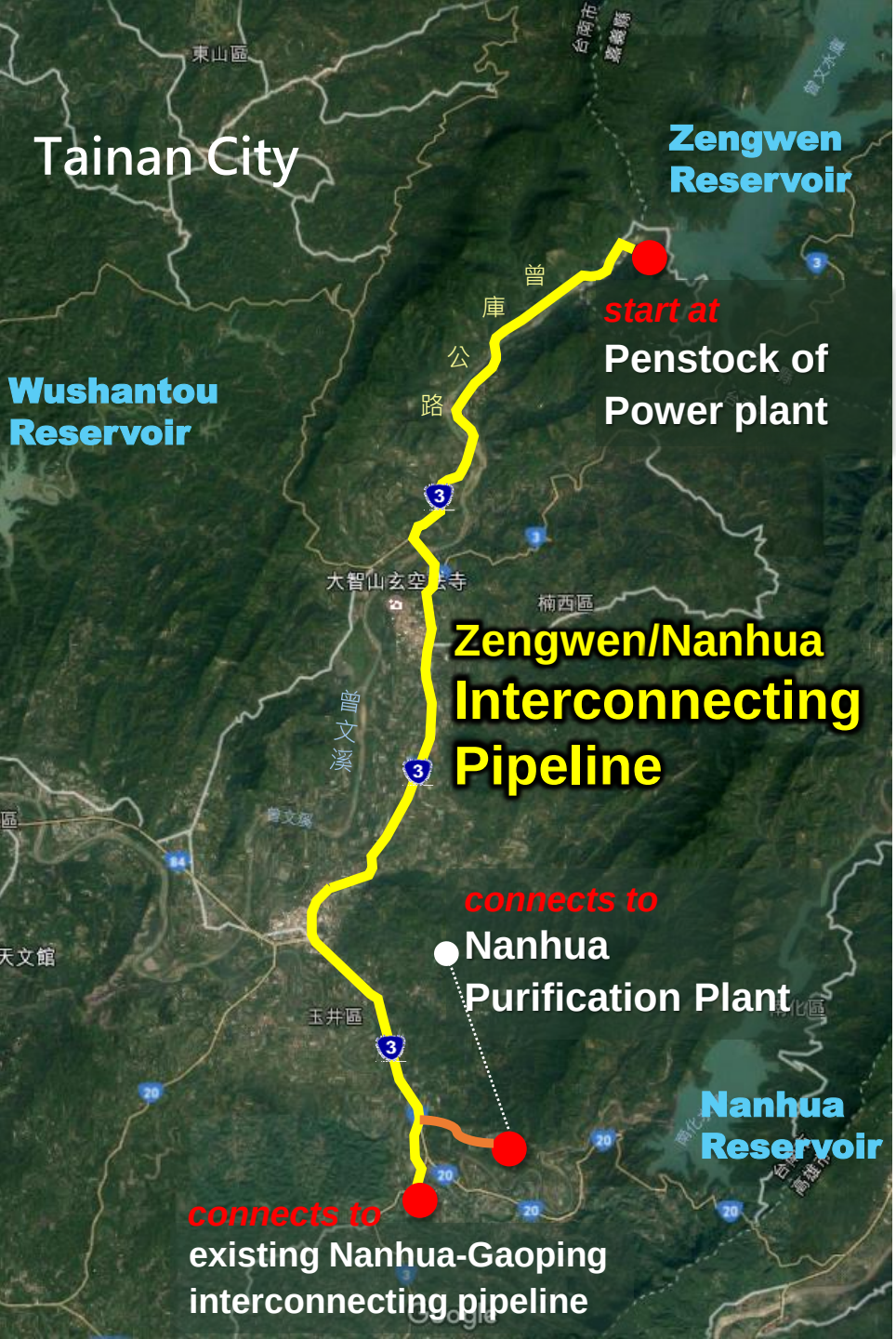


To improve the water supply in southern Taiwan ...

After the project reaches completion, we can…

- ✓ Increase a backup pipeline to support
- ✓ Connect water resources of main reservoirs
- ✓ Dispatch water resources more flexibly
- ✓ Lower water shortage risks

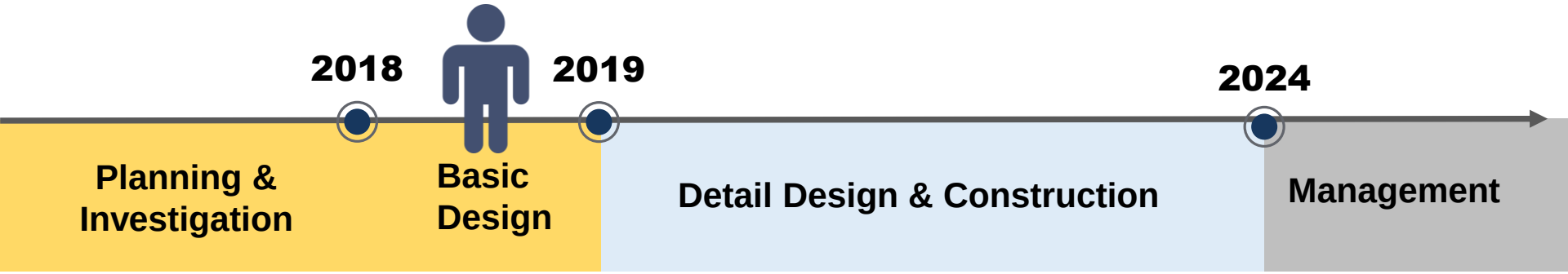
2 Main Content of the Project



- **Starts at**
  Penstock of Power plant
- **Connects to**
  1.Nanhua Purification Plant
  2.Nanhua/Gaoping Pipeline
- **Total length**
  25 km
- **Max discharge capacity**
  800,000 CMD

Period & Expenditure

✓ **Period**：2019~2024



✓ **Total Expenditure**：12 billion NTD
(0.4 billion USD)

Year	2019	2020	2021	2022	2023	2024	Total
Expenditure (*million NTD)	39	534	967	2,251	3,346	4,325	12,000

Tainan City

Zengwen Reservoir

Wushantou Reservoir

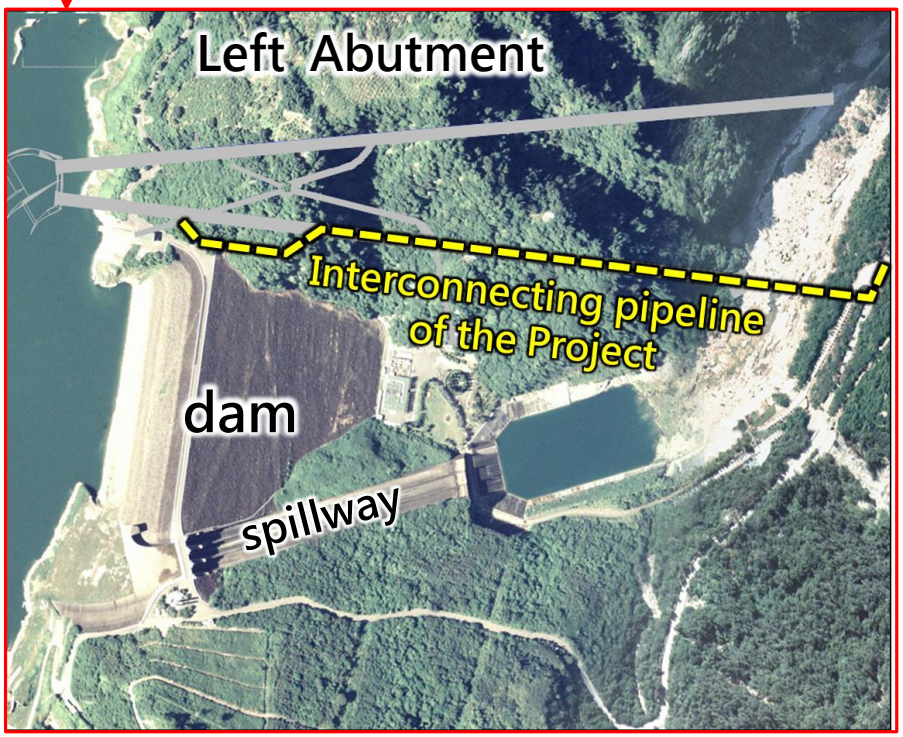
曾庫公路

Zengwen/Nanhua Interconnecting Pipeline

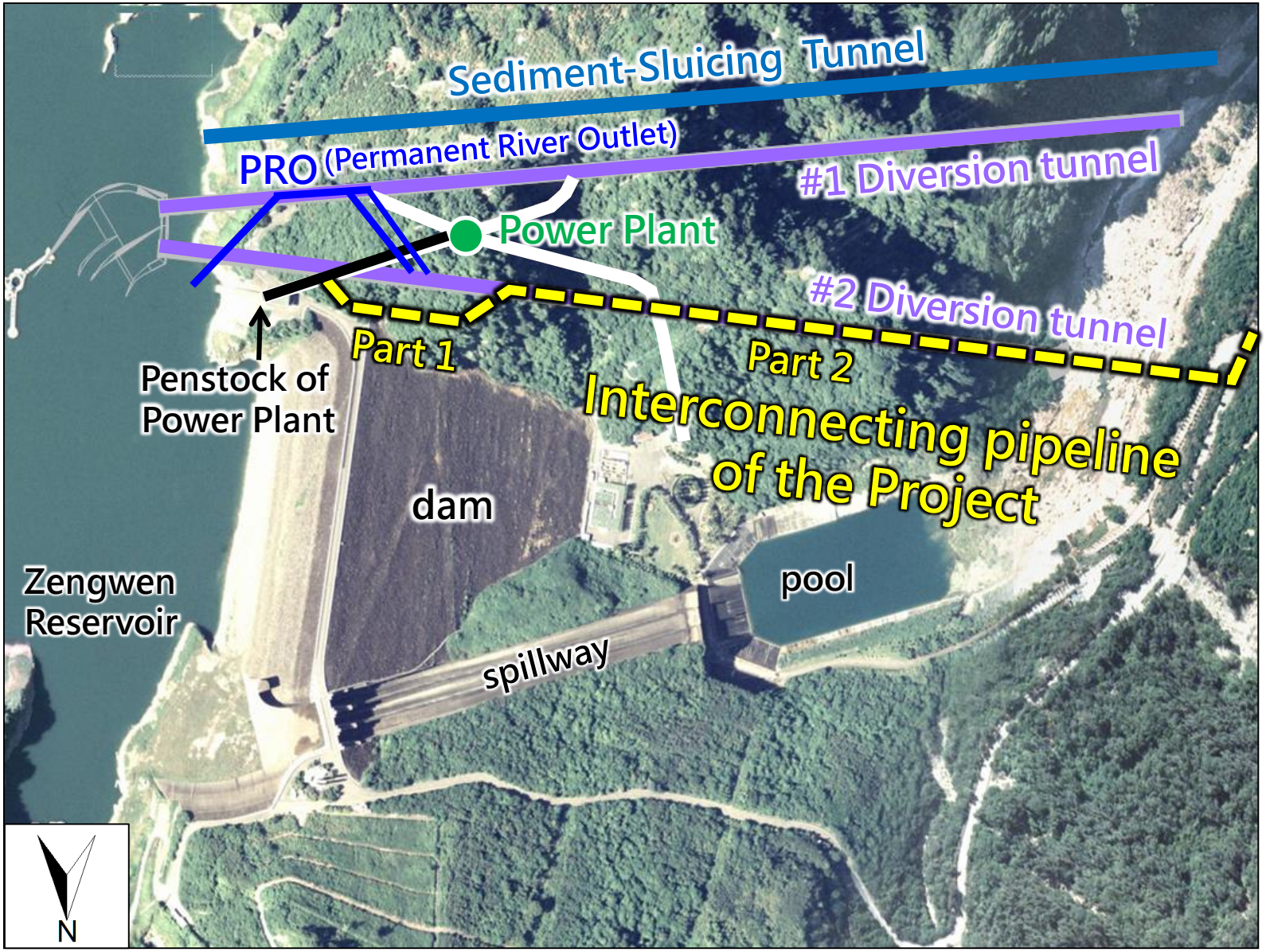
Nanhua Reservoir

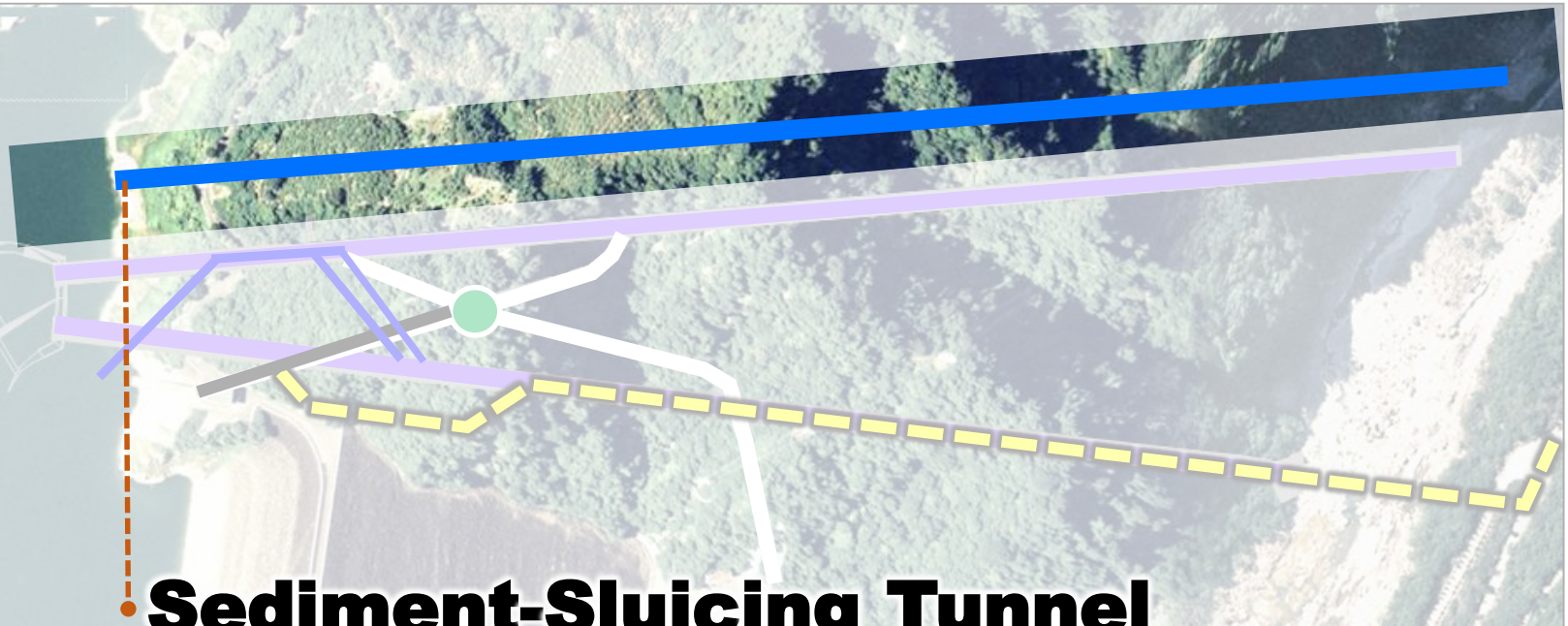
connects to
existing Nanhua-Gaoping interconnecting pipeline

Intake Segment of the Pipeline



Plan view of Intake Segment



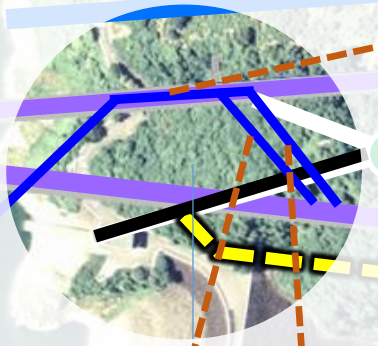


Sediment-Sluicing Tunnel

Design discharge：995cms

Expected Average Annual Sediment Sluicing

= 1.04 million m^3



PRO(Permanent River Outlet)
provides water when the power plant stops running.

Ventilation Tunnel for PRO

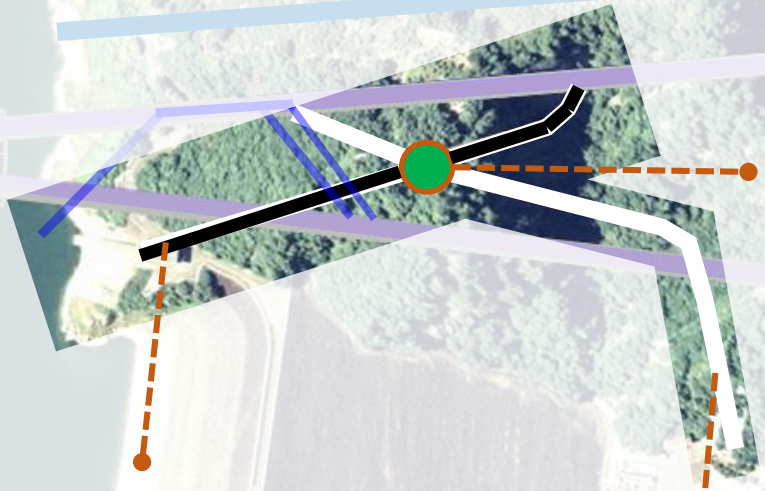
Maintenance Tunnel for PRO

1 No.1 diversion tunnel

- It connects with the hydropower plant penstock.
- Water has gone through the tunnel after generating electricity.

2 No.2 diversion tunnel

- No water has gone through it since the reservoir started working.
- It provides an access to PRO operating room.



Hydropower Plant

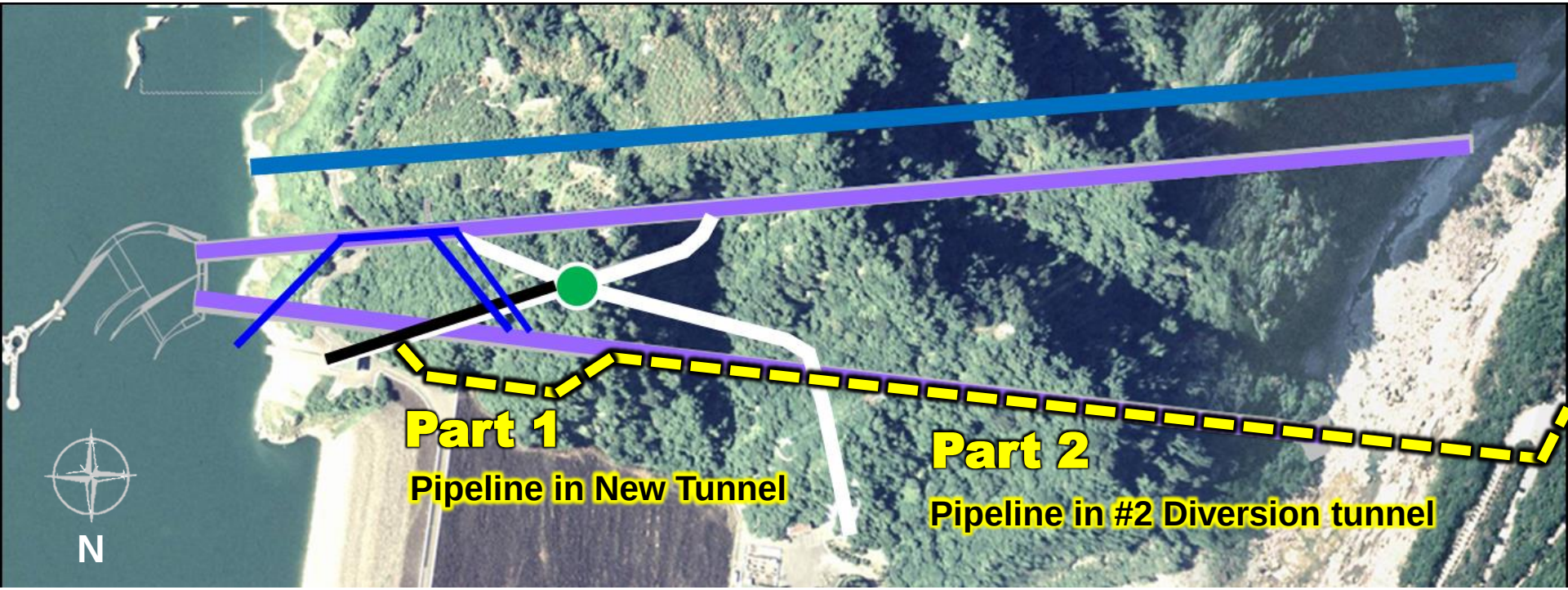
56 cms

Penstock

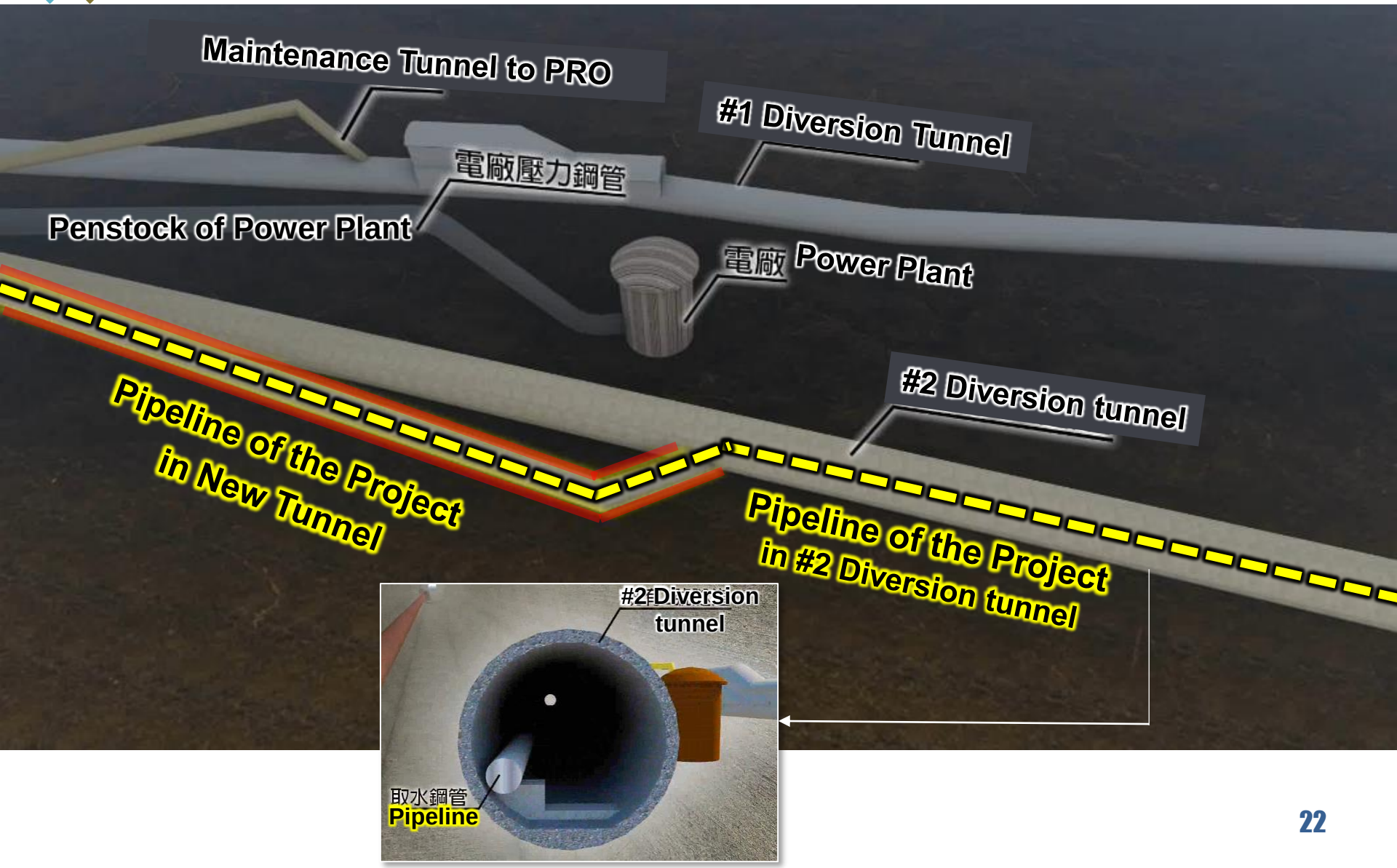
Diameter = 3.8m

Access Tunnel

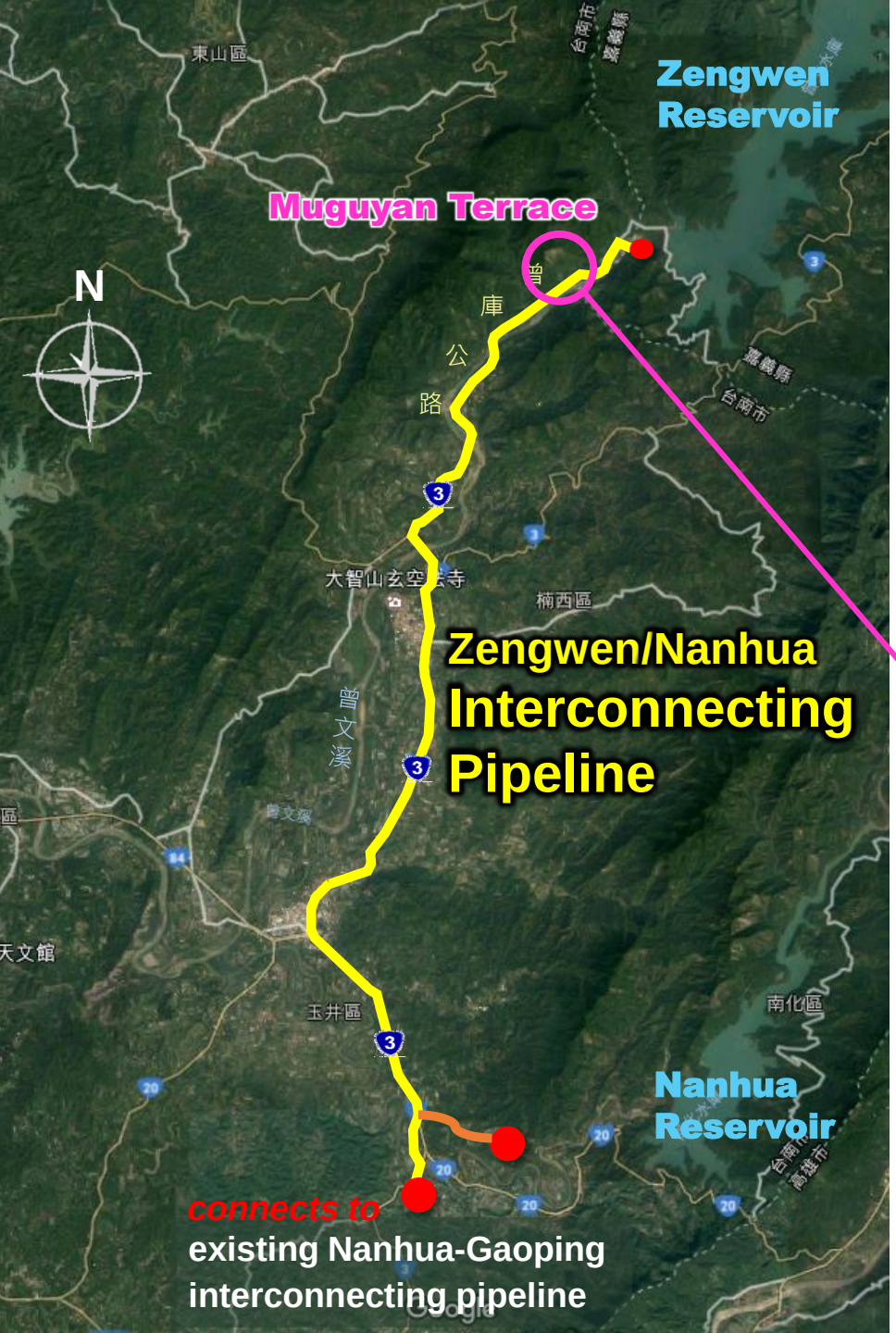
The Intake Segment of the interconnecting Pipeline

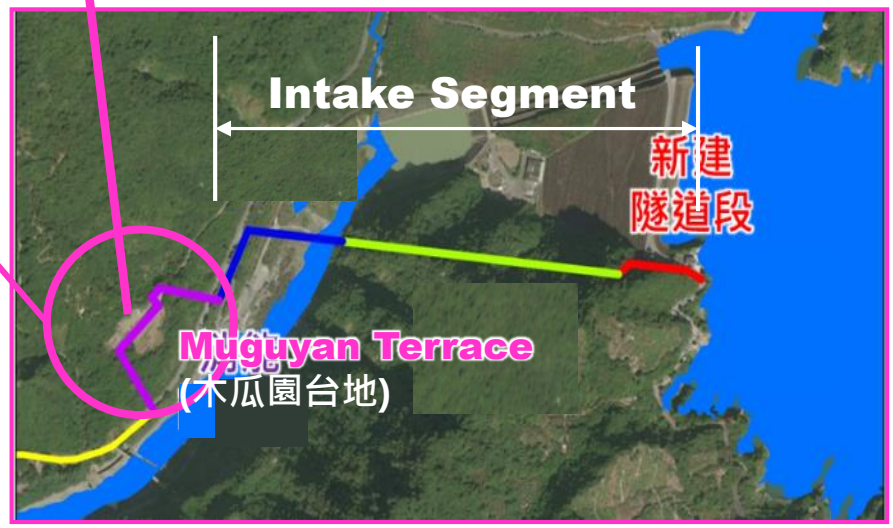


3D View of Intake Segment



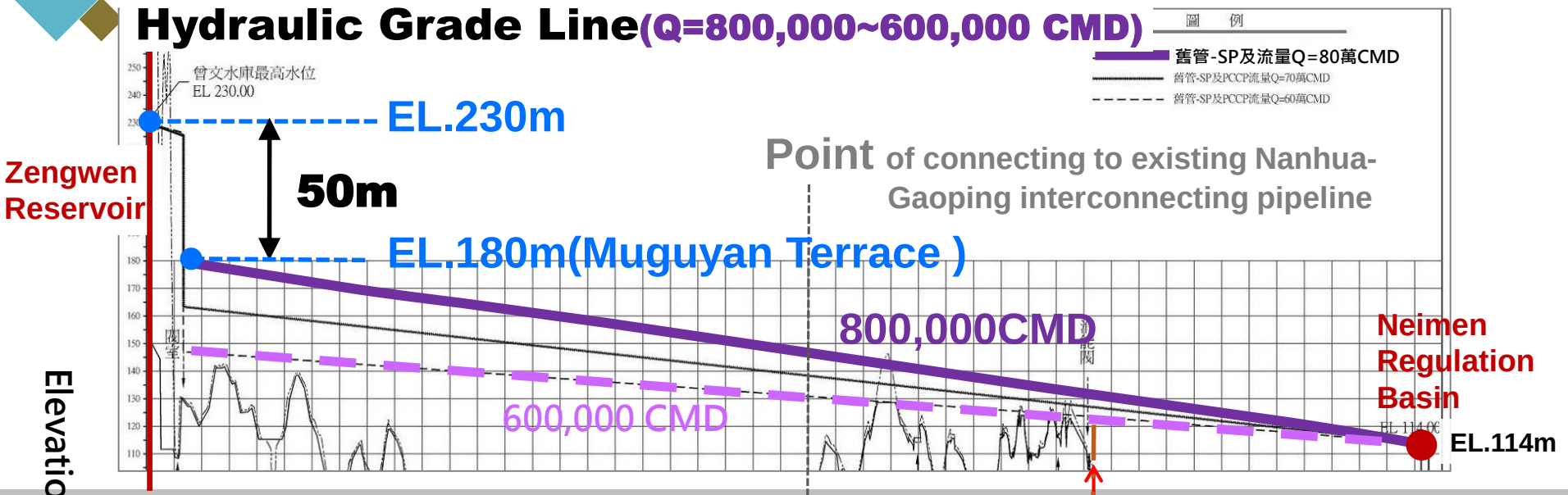
Energy Dissipation
Segment of the Pipeline



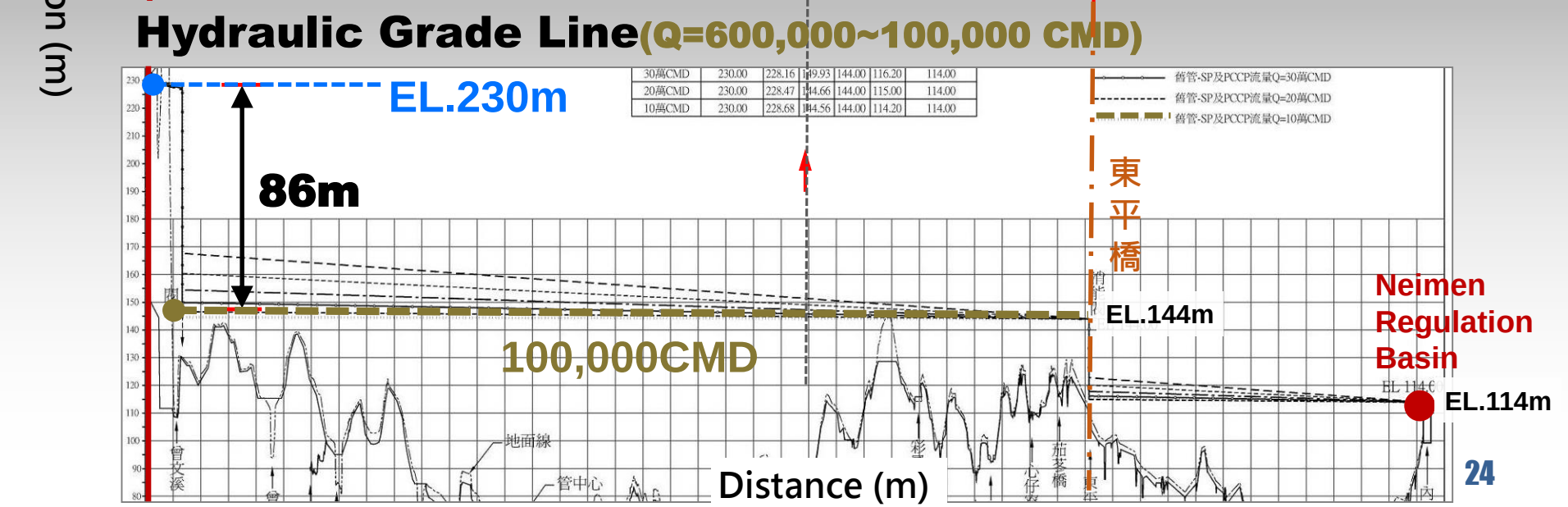


Excess Energy

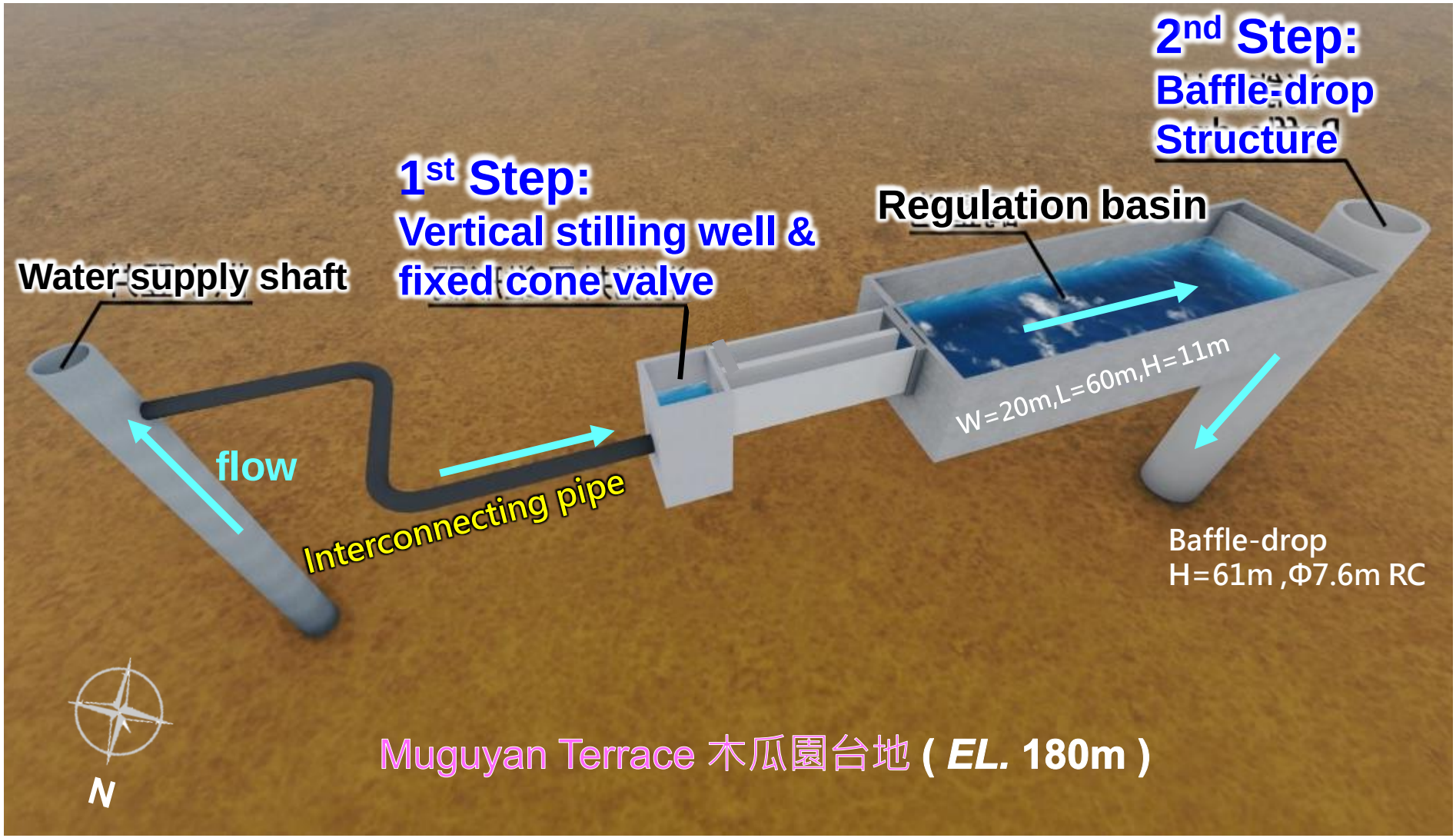
Hydraulic Grade Line(Q=800,000~600,000 CMD)



Hydraulic Grade Line(Q=600,000~100,000 CMD)



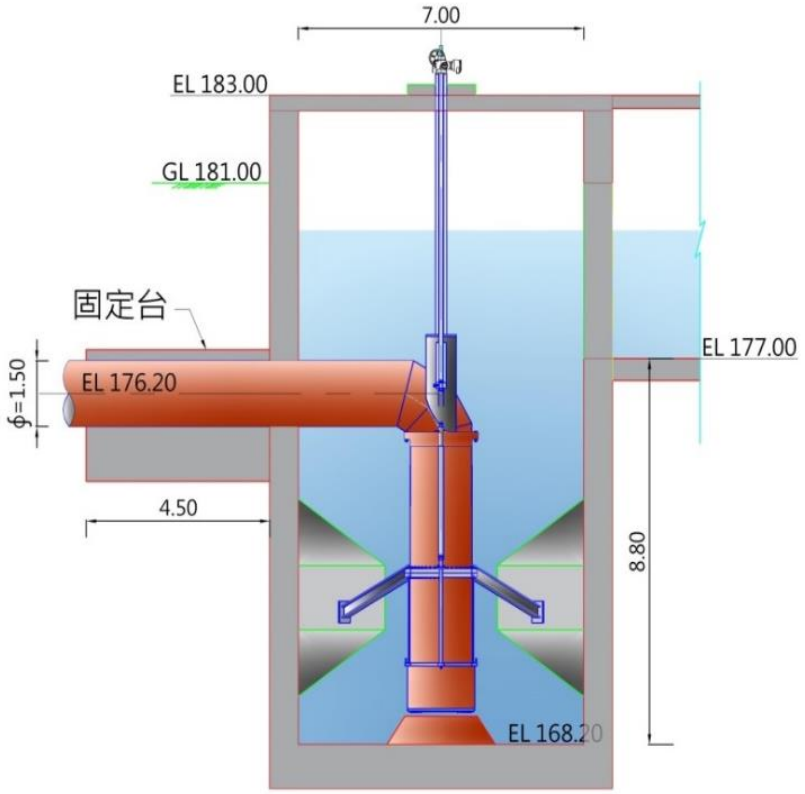
Energy Dissipation Design



2-Step Energy Dissipation

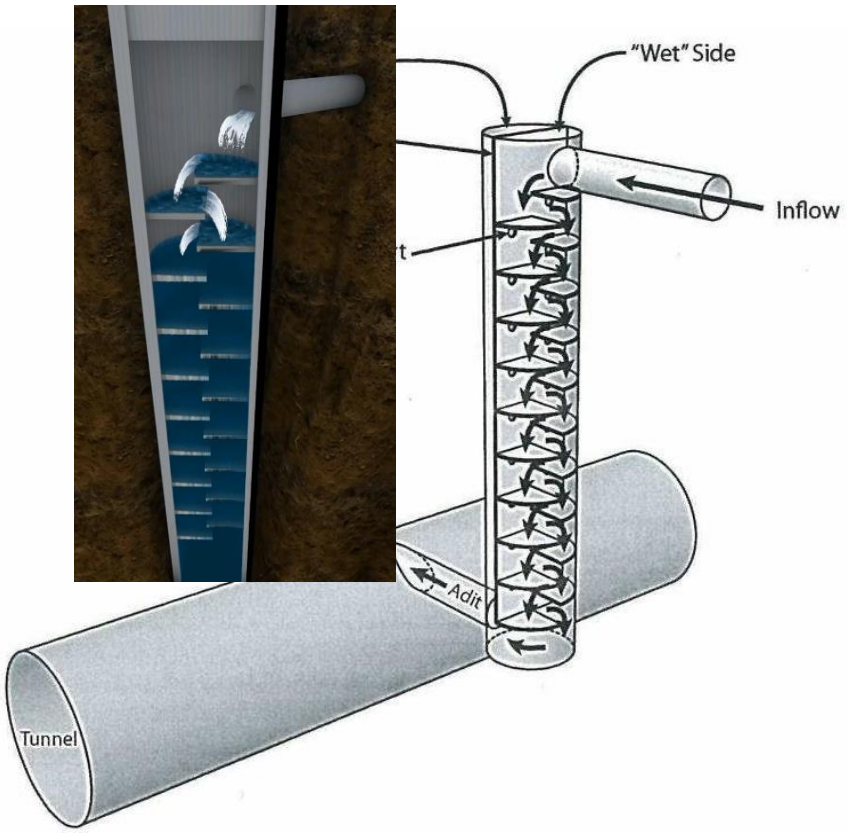
1st Step:

Vertical stilling well & fixed cone valve



2nd Step:

Baffle-drop Structure

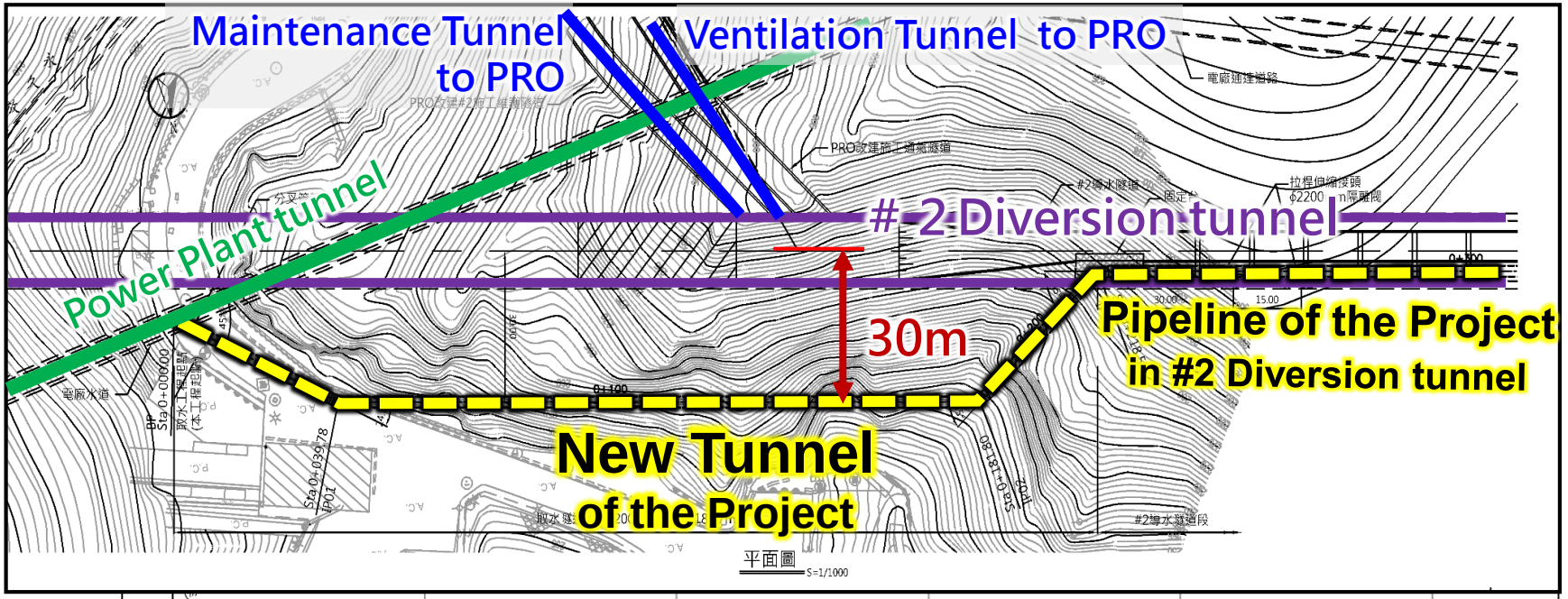


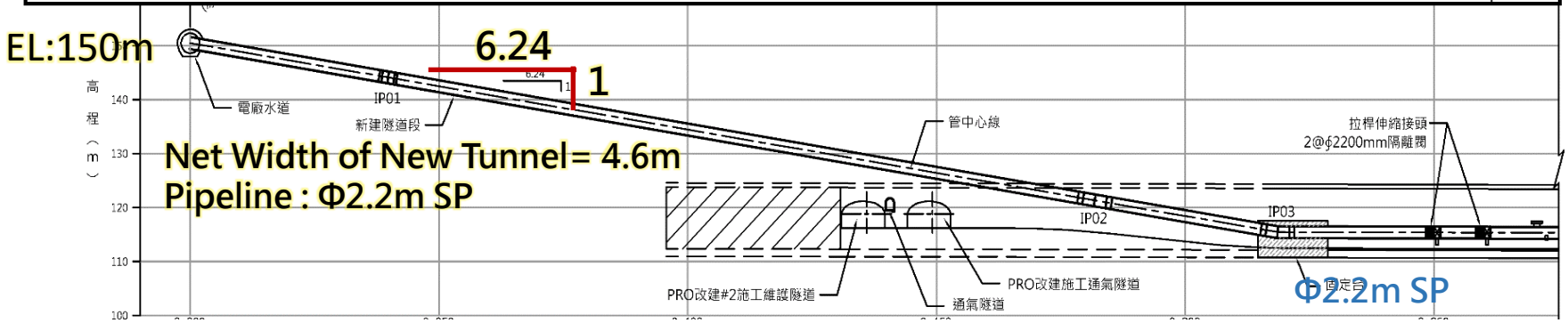
3

3 Crucial Issues
in the Left Abutment

Issue 1 : Safety of Tunnel Excavation

- ✓ Impact of the new tunnel excavation in the left abutment on the safety of existing tunnels





Factor of Safety

"*Underground Excavations*" *(by Hoek & Brown)*

$$D_h = 2.5 \times (a_1 + a_2) \times F.S.$$

a_1=6m ;

a_2=2.25m ;

D_h=30m

D_h : Horizontal distance

a_1 : radius of #2 diversion tunnel

a_2 : radius of new tunnel

F.S. : factor of safety

⇨ **F.S. = 1.45** ……OK!

i.e. **The excavation of new tunnel won't influence the safety of existing tunnels.**

Issue 2: Water Hammer on Power Plant

- ✓ **Water hammer effect on the power plant system due to closure of the new intake pipeline.**

- ✓ **4 Simulation Scenarios :**

  Scenario A: **Current condition**, total load rejection

  Scenario B: Total load rejection, new pipeline in operation

  Scenario C: Power plant in operation, new pipeline closure

  Scenario D: Total load rejection, new pipeline closure

  (load rejection：電廠跳機，new pipeline closure：本聯通管關閉)

Simulation Results

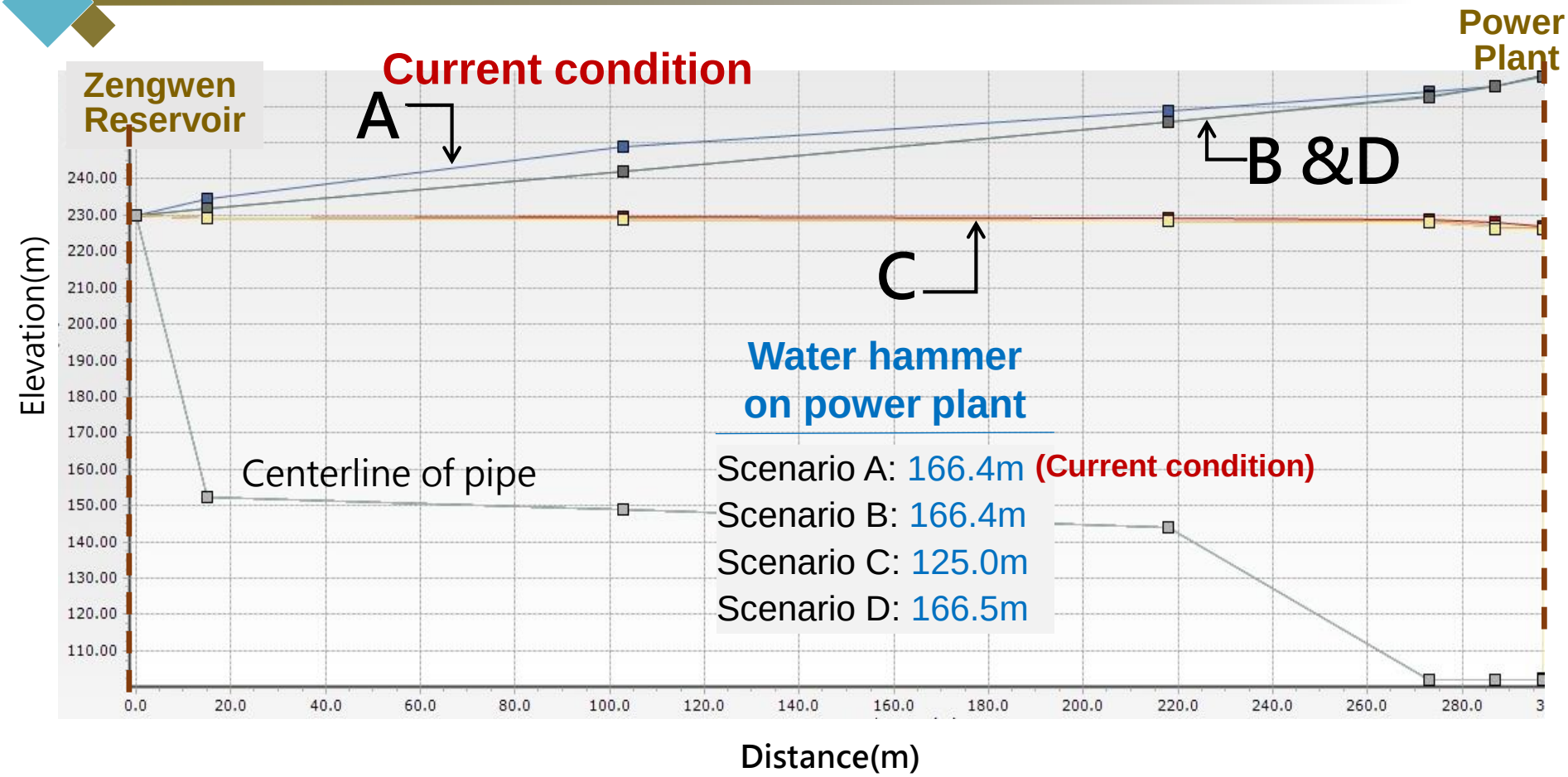
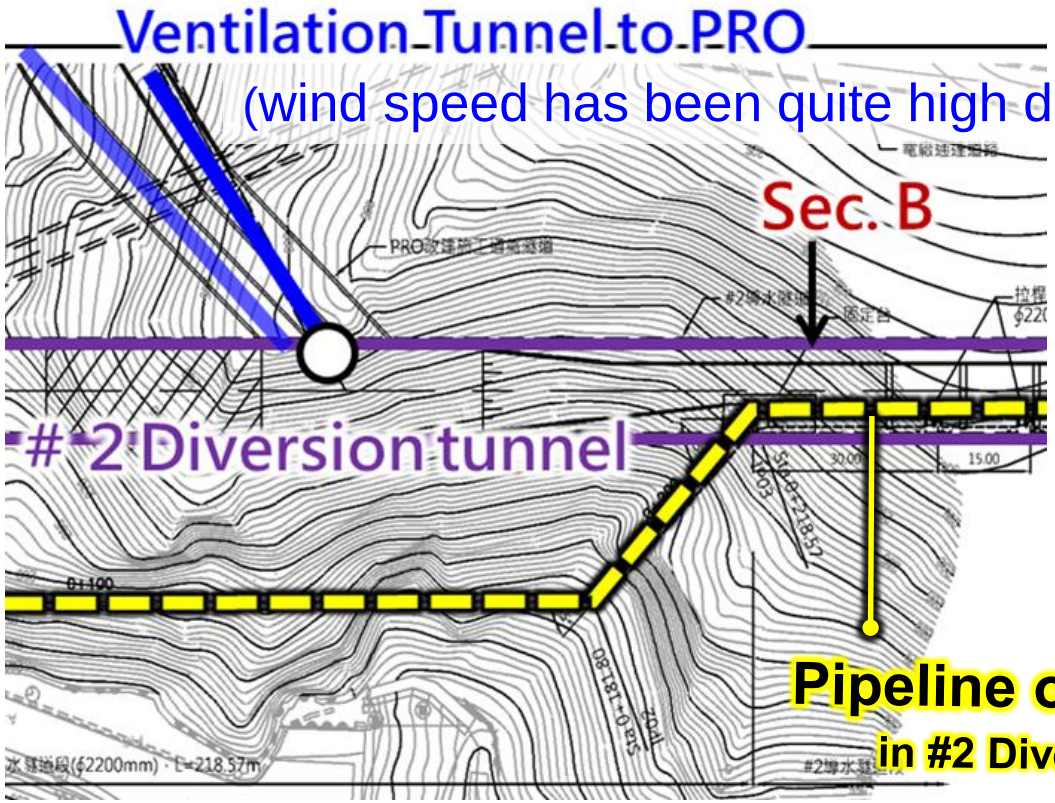


Fig. Analyzed Maximum Pressure Envelops due to Load Rejection and Closure of Flow Control Valve

⇨ **Impact on the existing power plant system from closure of new intake pipeline can be neglected.**

Issue 3 : Influence on ventilation

✓ **Influence on ventilation required for PRO**



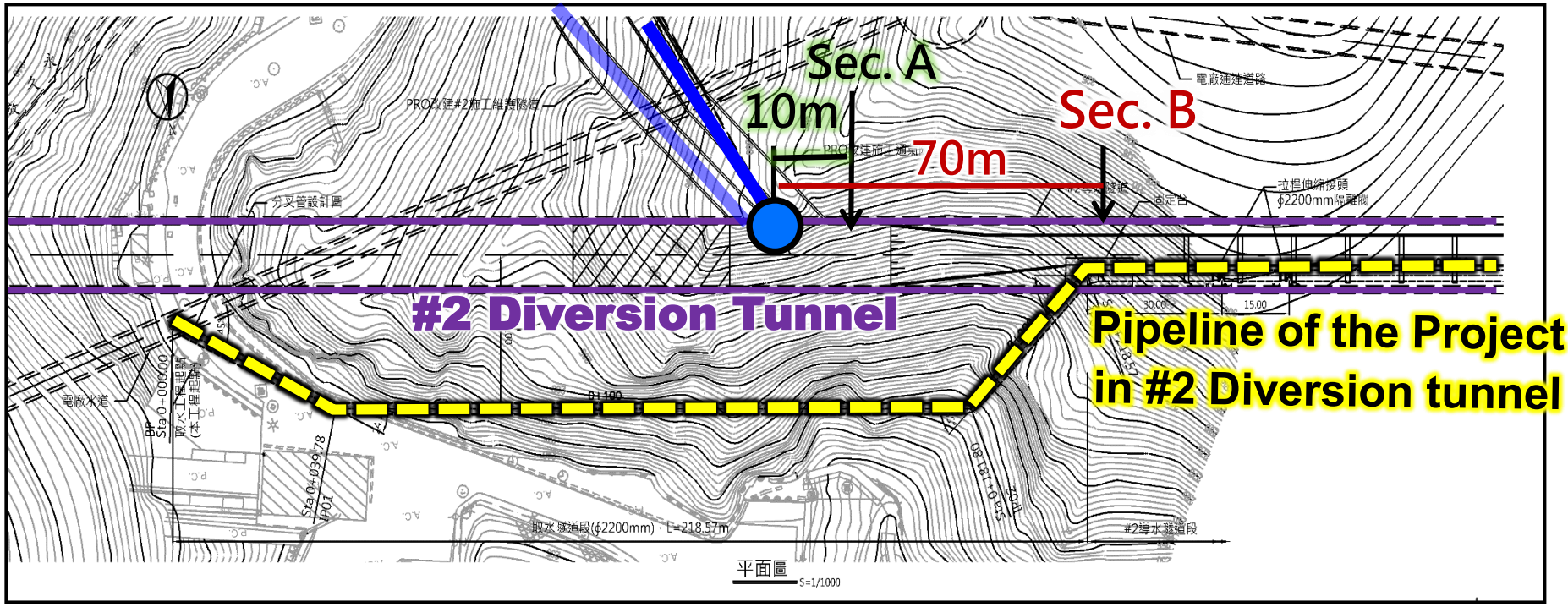
(wind speed has been quite high during PRO operation.)

Pipeline of the Project
in #2 Diversion tunnel

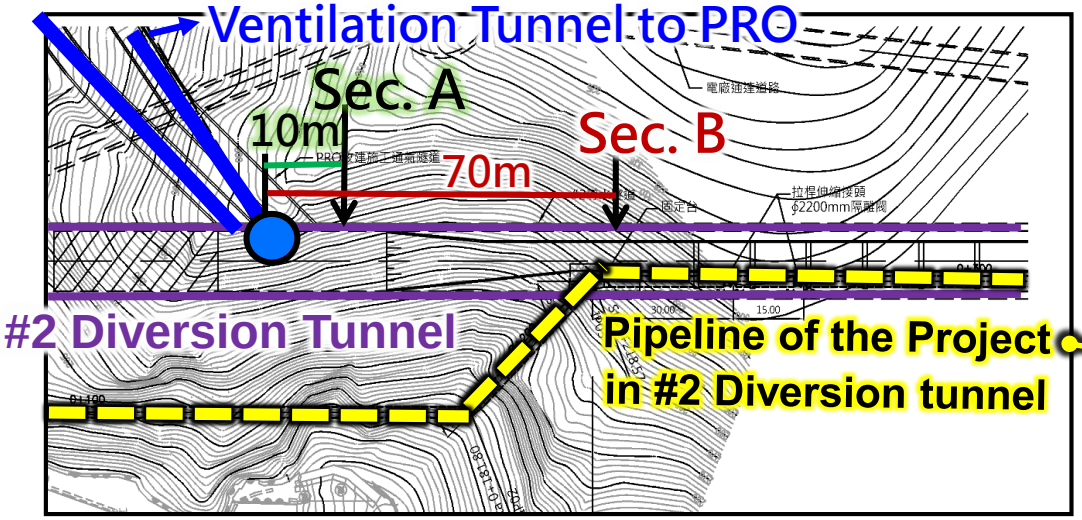
⇨ Evaluate the lack of ventilation caused by the reduction in section area.

Issue 3 : Influence on ventilation

Ventilation Tunnel to PRO



Calculation Results



Sec. B after construction

#2 Diversion tunnel

	Cross-Sectional Area	
	Current Condition	After Construction
Sec. A	74 m^2	O.K
Sec. B	109.51 m^2	88.75 m^2
Sec. of Ventilation tunnel to PRO	22.39 m^2	

⇨ **It is judged that the project won't have obvious effects on ventilation required for PRO.**

Short Conclusion

intake segment of this pipeline~

Issue 1

Impact of New Tunnel Excavation

Issue 2

Water Hammer effect on Power Plant

Issue 3

Influence on ventilation required for PRO


Thanks for listening